The Dock & Harbour Authority

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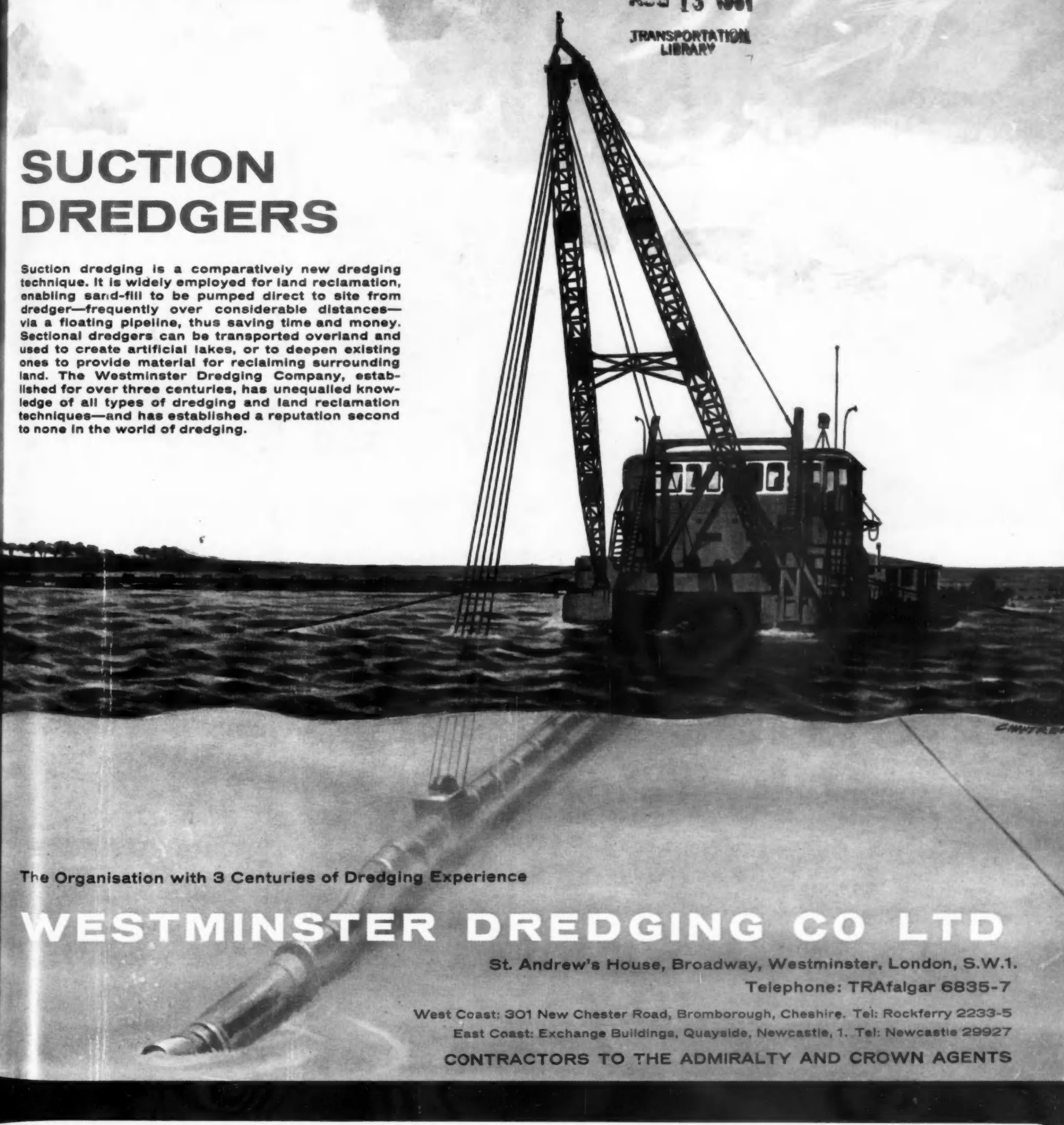

The Dock & Harbour Authority

An International Journal with a circulation extending to 85 Maritime Countries

No. 489

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Editorial Notes

The Port of Rostock

From time to time many and varied reports have been issued purporting to give facts on an ambitious development scheme to make Rostock one of the major ports of the Baltic, and in view of the enquiries this Journal has received during recent months, we are publishing in this issue as many details as have been made available to us.

Readers will appreciate that it is difficult to obtain a clear picture of the growth of this port, shrouded as it is in propaganda. However, there is no question that, under the direction of the East German Government, impressive developments have taken place and the new accommodation for shipping and the cargo handling facilities installed provide an example of what can be achieved under a regime which is foreign to the conception of the countries of the free world.

It is difficult to judge this policy of development according to the regular processes of trade and economics which apply in the western democracies as the cost, in money and human endeavour, is not regarded in the same light in Communist countries. A striking example of this is the statement that women and children were "voluntarily" employed to collect 60,000 tons of rock to build the new mole.

As for the further extension plans which the article suggests will be essential to enable the East German economy to cope with the anticipated growth in the volume of trade, we leave it to our readers to judge to what extent they may be justified.

The Estuary of the Seine

The new navigation channel connecting the marine part of the estuary of the River Seine to the river part proper leading to the Port of Rouen was recently opened and the occasion was marked by an impressive ceremony such as the French people excel in presenting.

Among the papers prepared for the guests at the opening was a general account of the scientific investigations carried out bv Sogreah to ensure that the channel would remain serviceable for as long as possible. The account takes the form of an exposition of the so-called "historical" method of using hydraulic models in contrast with the analytical and more abstract method of basing design on principles one degree detached from day to day practice, requiring evaluation of many physical properties of the river and difficult to apply in such a complex problem as this. The investigators had the benefit of annual river surveys going back to 1864. During this period there have been substantial artificial and natural changes in the estuary, including an eighteen year cycle of channel movements, so that agreement between the model and the changing full scale river could be proved over an unusually long period. The model reproduced these changes well and thus provided a sound base for assessing the behaviour of the upper part of the estuary for decades to come.

The estuary of the Seine has a special place in the history of hydraulic models of tidal rivers and in the affection of not only French engineers. Pioneering model experiments on it were carried out, partly in this country, nearly 80 years ago when the idea of using a loose bed model to find out how to control a river or an estuary was not taken seriously by more than a small number of Civil Engineers. We are glad to include in this issue a translation of the paper circulated at the time of the opening.

The P.I.A.N.C. Congress at Baltimore

Arrangements for the XXth Congress of the Permanent International Association of Navigation Congresses, to be held at Baltimore, U.S.A., from 11th to 19th September next are nearing completion. Some hundreds of delegates from 35 nations have already signified their intention of attending the Congress, which is held at a different venue every four years, the last being in London in 1957.

The President of the Congress is Senator John M. Butler of Maryland and Major-General Charles G. Holle, U.S. Army (retd.) who was Chairman of the American delegation to the XIXth Congress in London, is Secretary-General. Governor J. Millard Tawes is Chairman of the Organising Committee at 22 Light Street, Baltimore 2, Maryland.

It is hoped that Mr. John F. Kennedy, the President of the U.S.A., will preside over the opening session which is to be held in Shriven Hall on the campus of Johns Hopkins University. The technical sessions which follow will be divided between inland and ocean navigation and will be conducted simultaneously.

As most of our readers are already aware, the very successful London Congress was fully reported in this Journal, and we hope to publish a report of the Baltimore meetings in due course. The aim of these Congresses is the exchange of information leading

to the more efficient use of the world's seaports and waterways, and the subjects for the technical papers to be presented at Baltimore include:

(1) Criteria for economically justifying new inland waterways or improving existing waterways;
(2) Engineering problems that must be solved to provide navigation facilities in a system of multiple purpose dams;
(3) Measures necessary to ensure uninterrupted day and night navigation under all weather conditions;
(4) Propulsion of vessels by push-towing;
(5) Developing barges and other floating plants for use on shallow rivers or waterways of modest dimensions;
(6) Locating, designing and maintaining approach channels from deep water to harbour areas;
(7) Measures to be adopted for accommodating nuclear powered ships in maritime ports;
(8) Removing wrecks from navigable waterways and refloating stranded or sunken vessels; and
(9) Determining the movement of sand and silt along coasts, in estuaries, and in maritime rivers.

Several subjects discussed at the three previous Congresses are also on the agenda.

All technical papers are classified as "Questions" or "Communications." Questions can present either a description of the way the subject was dealt with in the country of the author or an account on a new theory applicable to the subject. This type of paper is submitted for discussion, which may or may not be followed by a vote on conclusions.

Communications present an account of how navigation problems were solved in the country of the author. The primary purpose of communications is to increase documentation on a specified matter. These papers do not lend themselves to conclusions.

In addition to the technical sessions, social meetings and visits in the Baltimore—Maryland—Washington area have been organised for the delegates and their ladies. The opportunity is also being afforded for the delegates to participate in post-Congress tours. While these are not an official part of the Congress and are taken at the delegate's expense, they are a strong attraction and are designed to implement the meetings with visual observation and inspection of outstanding navigation facilities in both the U.S.A. and Canada.

Fire Prevention

A National Fire Prevention Week is to be held throughout the United Kingdom from 30th October to 4th November next. This event, which will be the first of its kind in this country, is being arranged jointly by the Fire Protection Association and The Royal Society for the Prevention of Accidents. The idea of the Week was promoted by the Home Secretary who, at the National Fire Protection Conference 1960, called attention to the serious losses caused by fire and asked for more publicity to pinpoint the dangers.

The Home Office and Ministry of Labour are giving their support and arrangements are being made for nation-wide publicity through such media as the press, radio and television.

The need for a campaign of this nature needs no emphasis. The annual report of the Fire Protection Association for 1960 states that for the second consecutive year, the nation's fire damage has cost nearly £44 million and lists 43 fires each costing over £100,000 which contributed to this total. Two fires caused serious loss of life. In Glasgow, 19 firemen and salvagemen lost their lives and 11 people died in a department store fire in Liverpool. The more recent fire in a club in Bolton in which again 19 people lost their lives provides forceful evidence that, at present, fire precautions leave a lot to be desired.

The National Fire Prevention Week has therefore been arranged to focus public attention on the menace of fire, to create awareness of its main causes, and to give elementary guidance on methods of fire protection.

As regards the large loss fires which account for nearly a half of the total annual fire damage (43 per cent of the 1960 total) the F.P.A. annual survey shows that they can be attributed to lack of means of discovering a fire in its early stages and to lack of built-in means of confining the fire to its area of origin. Industrial managements claim that subdivision of the large areas they require for production is wasteful of space and economically unsound but, accepting these as cogent arguments, it is suggested that more can be done by architects and production specialists to include the risk of fire in the other considerations which govern designs and layouts.

International Association for Hydraulic Research

This International Association, founded in 1938, is a world-wide organisation of engineers and scientists whose object is to stimulate and promote all aspects of hydraulic research. The Association holds Congresses at two-yearly intervals and symposia on subjects of specialised interest are held from time to time. The Papers and Proceedings of the Congresses are published and form valuable records of the latest developments in hydraulics.

The Institution of Civil Engineers has set up a British National Committee to organise a British Section of the Association and to co-ordinate and encourage participation by engineers and scientists in Great Britain in the Congresses and other activities of the Association.

The British National Committee is drafting a Constitution for the British Section in which it is proposed that meetings may be organised in Great Britain from time to time for the discussion of subjects of interest to members of the Section. The Committee has invited the International Association to hold its Ninth Congress in London in 1963. This invitation will be considered by the International Council in Belgrade in September, 1961.

At present the membership in Great Britain is small and the British National Committee wish to call attention to the existence and activities of the Association; to seek new members in order to stimulate hydraulic research in this country; and to ensure that the British Section is well supported.

A memorandum giving details of the Association and application forms for membership are obtainable from the Secretary, British Section, I.A.H.R., c/o The Institution of Civil Engineers, Great George Street, London, S.W.1.

Cargo Handling Conference

The fifth biennial general assembly and conference of the International Cargo-Handling Co-ordination Association is to be held at the Waldorf-Astoria Hotel, New York, from 5th—9th September next. Among the papers to be presented and discussed are the following:

International implications of the use of containers;
Studies in producer-to-consumer use of containers;
Impact on port facilities of recent developments in cargo-handling methods;
Automation and labour-management relationship problems;
Packaging cargoes for export;
International standardisation of cargo marking;
Cargo loss prevention;
Cargo-Handling problems in under-developed countries.

Concurrently with these discussions, a cargo-handling equipment exhibition will be held on Pier 9, North River, in Manhattan. Further information is obtainable from I.C.H.C.A., 111 Eighth Avenue, New York 11.

Development of the Port of Rostock

Important Adjunct to East German Economy

By D. REES

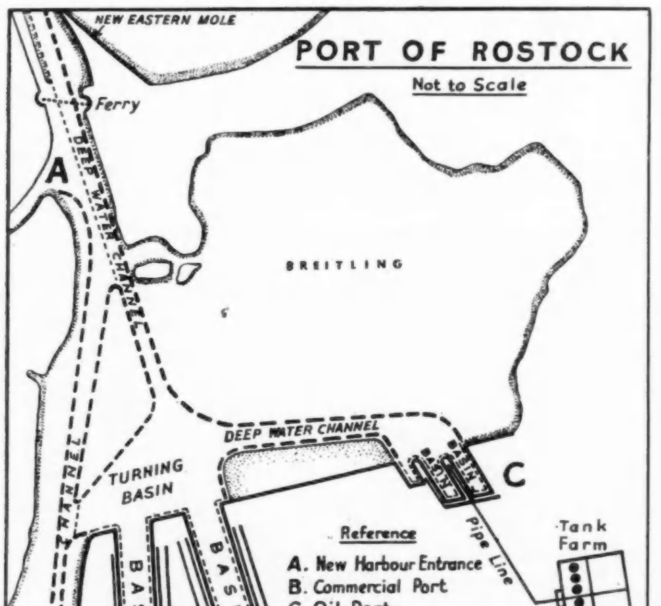
The Port of Rostock on the Baltic which, up to the middle of the 19th century, took third place after Hamburg and Bremen in handling Germany's overseas trade, is making a determined effort to regain its old importance as a result of economic necessity and the division of the former Reich.

Before the Second World War, the old harbour of Rostock, on the Warnow River, one hour's sailing time from the open sea, was a straggling, empirically developed port with an annual turnover of about one million tons of cargo. Situated in the shadow of the old Hanseatic town and with inadequate rail communications with its hinterland, the port was limited to ships of up to 5,000 tons gross, and trade was for the most part confined to coal, fish and grain from East Prussia and timber and piece goods from the Baltic and North Sea ports.

Rostock's decline is attributable to Hamburg's growing importance at the turn of the century and to the development of fast internal rail communications from all parts of Germany to the North Sea area. The mile of quays only 100 yards from Rostock's main street, the Langestrasse, were for the most part old fashioned and ill-suited to modern needs, although some of them have since been modernised. Up to the end of the war, the 3,000 dock workers largely loaded and unloaded ships by hand.

The old town harbour still handles about one million tons of cargo annually, but by comparison the new harbour, dug literally from fields, meadows and marsh ground four miles nearer the sea, plans an annual handling capacity of more than seven million tons, including one million tons of oil, when completed in 1965. The new harbour, barely half finished, is already handling 2,800,000 tons of cargo annually, and space has been left in the final plans for extensive development of the present site if this is found to be necessary.

A berth has been set aside in the commercial port where passenger ships from the Soviet Union will tie up. In addition, according to Rostock authorities, Britain and Finland have shown considerable interest in running ships to Rostock. Planning authorities have also taken into consideration the future possi-



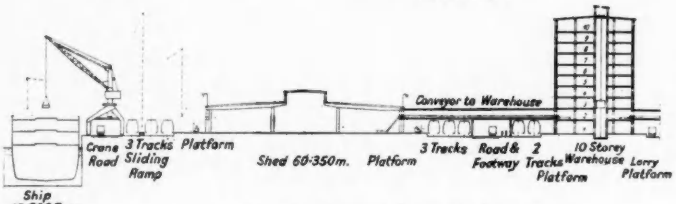
Above: Sketch Plan and right: Artist's model of the Port of Rostock showing:— **(Top left)** The Commercial Port comprising (right) Bulk Goods Quay, (centre) General Cargo Quay, (left) Fruit and Meat Quay with Refrigeration and Disinfecting Plants and also the terminal of the new ferry to Gedser. **(Top right)** The Oil Port showing 2 Basins, Pipelines and Tank Farm. **(Bottom right)** Marshalling Yards. **(Bottom left)** The Timber Port and Storage Area (now under construction).

bility of several more dock basins between the southern timber port and the commercial port and another basin between the commercial port and the oil harbour. Large areas of land behind the commercial port are available for industrial sites.

The Present Position

The division of Germany after the Second World War into east and west sections left the German Democratic Republic with only six ports and none of the first rank. Hamburg and Bremen were

Cross section of free loading area on general cargo quay.



Cross-section of General Cargo Quay

for all practical purposes in a foreign country, and Stettin had gone to Poland as Germany's eastern frontier moved west to the River Oder.

Of the ports that were left, only **Wismar** was more important than the old Rostock harbour, and ships up to 10,000 tons gross were able to dock there. About 7,000 people are employed at the Matthias Thesen shipyard in Wismar, where the 1960 production figure was 300 million marks. In addition to passenger ships, the Matthias Thesen shipyard also builds large fishing and fish processing ships.

Warnemuende, once a fishing village nearly 9 miles from Rostock and now the site of another large shipbuilding yard, is at the western entrance of the river, about halfway along the new canal to the Baltic. The ferry sailing from this port to Gedser in Denmark carries trains, cars and passengers. On completion of the new commercial port at Rostock, the ferry will operate from two berths at the end of a 550 yard long dock adjoining the fruit handling berths.

The Port of **Stralsund** can handle ships up to 1,000 tons gross. **Sassnitz** is only a fishing port, but has the southern end of the main East German ferry to Sweden via Traellborg. There are also small ports, used for little more than coastal traffic, at **Greifswald** and **Wolgast.**

East German overseas trade at present transhipped through Hamburg amounts to about one million tons a year, or about 12 per cent of the total, and this figure is expected to remain about the same after conclusion of the new harbour works, in spite of certain anxieties in the West German port. East German trade circles explain that owing to the steady expansion of trade, the percentage dealt with at Hamburg should not be affected.

It is estimated that, when the Port of Rostock developments are completed in 1965, East Germany will be able to handle in all nearly 12 million tons of cargo yearly through her ports. This does not, however, take into consideration cargo carried on the Sassnitz-Traelleborg and Warnemuende-Gedser ferries, which trade has grown in the first instance from 293,000 tons in 1954 to 451,000 tons in 1960 and, in the second instance from 87,000 ton in 1955 to 150,630 tons by August 1960.

Construction of the New Harbour

Rostock's new harbour has been under consideration sinc 1950, and work started on October 27th, 1957. There are thre main divisions:

1. The commercial harbour (the most important)
2. Oil harbour
3. Timber harbour

The whole group will comprise 32 berths for ships up to 10,000 tons gross by 1965. Seven were completed by the end of March 1961, and three more will be ready by the end of the year. In 1965, at the end of East Germany's seven year economic plan, it is estimated that there will be about four and a half miles of quays in the new port. The entire scheme, including the new station and shunting yard, will cover an area of nearly 6 square miles. The distance from the dock entrances to the open sea is approximately 3½ miles, the shortest distance from any deep sea harbour to open water in the Baltic.

It is interesting to note that although Luebeck in West Germany is about 62 miles farther to the west, Rostock is three sea miles nearer the North Sea because of the eastward jutting Danish coast, making necessary a long detour from Luebeck to reach the Kiel Canal. Ships from Rostock use the canal rather than make the long sea passage, as this saves a whole day.

The present position in the three main divisions and future planning is as follows:

Commercial docks (berths completed at the end of 1961): Berths for bulk goods 2, and piece goods 6. Planned for completion by 1965: for bulk goods 4, piece goods 13, and special cargoes 2.

Oil dock: one berth already in use and a second will be completed this year.

Timber dock: no berths will be completed this year but 11 will be ready by the end of 1965.

By 1965 the commercial dock will be able to handle ships carrying general cargo up to 12,000 tons, bulk cargo ships up to 15,000

New berths under construction at the commercial port

tons, and tankers up to 20,000 tons with a draught of up to 32-ft. Ships with a draught of 24-ft. will be able to use the south harbour. Foundation works on the quays have been set so deep that later the docks can be deepened to about 40-ft. in the oil and commercial docks and to 33-ft. in the timber dock. The port is nearly 500-ft. wide in the commercial basins and slightly less in the oil and timber docks, so the largest ships using the Baltic can be accommodated. The 3½ mile long channel leading

to it from the open sea, which is at present about 390-ft. wide and 34-ft. deep is to be widened still further this year and it is planned to deepen it eventually to 40-ft.

Nearly twelve million cubic yards of soil had to be removed in the first stages of excavation for the new harbour, and nearly 7,000 piles have been driven in the commercial port, but the actual construction of the harbour is only part of the work being carried out. People working on the huge development are at present living up to 19 miles away from the site, owing to Rostock's considerable post-war expansion. The town's population has grown from 120,000 in 1936 to 160,000 in 1961, and this is expected to rise to 200,000 by 1965. A tunnel is planned under the Warnow River, shortening the distance between the new harbour and Warnemuende, and a new housing estate for workers which will accommodate 60,000 people is being built on the left bank. Other housing estates are also planned. The small village of Petersdorf which had a population of some 200 was completely evacuated when work started on the port and used for housing the harbour workers. The villagers were moved elsewhere.

About 2,300 people are now employed at the new harbour and more than 60,000 tons of rock were collected voluntarily from all parts of East Germany by women and children to construct the new mole, leading about 650 yards out to sea. The new channel into the Baltic required this third mole to give protection from the East wind.

The driving force behind the new harbour works—figures for the cost of the undertakings are not yet available—is the idea of a quick turn-round port. Lack of storage space at the docks was one of the main problems that had to be overcome in developing the capacity of East Germany's overseas trade, although formerly direct transhipment from ship to railway trucks had been the common practice.

In view of a seasonal trade and the irregular arrival of ships, Rostock's new port is being constructed to facilitate quick despatch. The new railway station with its miles of track, the large amount of storage space at the docks, the provision of modern crane equipment, and the generous amount of space in which to handle the ships and their cargoes—in marked contrast to many

Storage sheds and cranes in the general cargo berths at the commercial port.

older ports with their jumble of wharves and warehouses—have all been designed to this end.

The harbour management intends to get the goods out of the ships as quickly as possible, so leaving the vessels free for speedy sailing. In many cases direct unloading into trains, already made up in the marshalling yard, will be possible, and the new autobahn connection with the big centres will ensure fast road transport for the carriage of special cargoes. Ships will be able to sail and arrive at any time because of the absence of tides in the Baltic and also the harbour is protected by the land from the prevailing south-west wind.

General Cargo Quays in the Commercial Dock

The two general cargo quays are on each side of the centre pier and are each equipped with two sheds 1,150-ft. long by 196-ft. wide which are separated by an open space used for cargo handling. Three railway tracks run in front of and behind the sheds

View of the oil harbour nearing completion.

while the centre line of the pier is used for road vehicles. The rail track arrangements differ from the usual in that there are no rail tracks in the portal crane. On the water side of the quay, there are three tracks of which the middle one is the main traffic line. The one nearest the dock is the assembly track, and the third is the ramp track. The assembly track can, by means of shunting, also be used as a loading track. Double sets of points make all these railway tracks serve the highest productivity.

The free loading space between sheds 1 and 2 at each quay is as long as two ship berths and will be used mainly for the handling of medium heavy goods. The provision of three loading bridges with swing cranes of about 105-ft. working radius makes it possible to move heavy loads by working two bridges together, and they will be able to reach all three rail tracks on the landward side of the sheds. The cranes can unload direct from ship into goods trucks or deposit their loads on the free loading space. Particularly heavy goods are moved by floating crane.

Each berth is equipped with 6 portal cranes with a working radius of 105-ft. and a lifting capacity of 3 to 5 tons. The apron on the dock side is about 33-ft. wide, giving ample space for two-way traffic with pallets and fork-lift trucks or trolleys. If needed, lorries can also use this area to load or unload into the sheds direct. The quay on the other side of the sheds is 23-ft. wide and railway trucks are loaded and unloaded here.

The share of lorry traffic in harbour undertakings varies considerably according to geographical conditions, and a study of a map showing the main stream of goods in East Germany clearly indicates the limits of road transport.

In Rostock, road transport is strictly separated from rail traffic to avoid the disturbance of cross traffic by lorries in the sheds or on the quay. Should road transport increase, large parking areas will be constructed immediately behind the harbour area.

Special Goods Quay

This quay which is about half as long as the general cargo quays is to be equipped in a similar way.

One of the sheds has been constructed especially for the handling of bananas and includes a ripening cellar and a sorting and temporary storage depot. Loading on special goods wagons and lorries takes place from an air conditioned room. Unloading the fruit from the ships will be by conveyor belt. Citrus fruit is handled in cases and apart from being held in air conditioning rooms until loaded into trucks and lorries, they are treated as normal piece goods. A special disinfestation plant has been built on one of the quays, and there is a refrigerated store for meat and fish cargoes.

Bulk Goods Quay

This quay will specialise in handling ore, coal, concentrates and raw phosphates. The three rail lines lie as close to the quay side as possible and conveyor belts facilitate the loading of the bulk cargoes from a central loading station. There is no roadway needed on this quay.

The Timber Harbour

In the main, timber is only imported during five months of the year and for this reason special planning of the facilities was necessary. The Rostock harbour authorities discussed the construction with British experts because of the great experience England has in importing timber. At present, the timber or southern harbour consists of only one berth but by 1965 it is expected that there will be 10 in use. The northern quay will be for special ships of 3,000 to 4,000 tons and will comprise 5 berths each 130 yards long; the southern quay will have 4 berths of the same length. The end of the quay constitutes another berth. All berths will be served by 13 cranes. A large space has been reserved at the east of the harbour for sorting, measuring, and storing the timber.

Shipping at a general cargo berth at the commercial port.

This harbour has been planned to handle about 1,000 tons of cargo a year for every yard of quay. When completed, it will be possible to unload a 10,000 ton ship in 8 to 10 hours. By 1965 timber imports, mainly from Finland, the Soviet Union and Sweden, will total 600,000 tons a year. Timber is largely used in the manufacture of artificial fibres, which is an important and developing industry in East Germany.

Oil Harbour

At present two tanks have been erected, each with a capacity of 6,540 cu. yds. One supplies diesel oil for the bunkering of ships. There will be two berths in use by 1962 capable of transferring the oil at the rate of 1,000 tons an hour, and it is estimated that, by 1965, the harbour will be able to store a total of 50,000 tons of oil.

Shipbuilding

There are two shipbuilding yards at Rostock, the Neptun Works in the old town, where submarines were built in World War II, and the Warnow yard, built on the site of the Arado Works, the former Heinkel bomber plant at Warnemuende. Both plants were totally destroyed in the war. The main hall at the Warnow works now covers about 24,000 square yards. The first of East Germany's 10,000 ton ships was built in Warnow in 1956.

The Neptun yard, where the first German iron screw steamer was built 100 years ago, now incorporates a technical training school.

Rostock University, founded in 1419, opened a faculty for the technology of shipbuilding in 1950.

Fishing Industry

The new developments at Rostock will lead to an extension of East Germany's fishing industry. About 40 per cent of the country's domestic fish requirements were supplied by their own industry in 1958. This is to be increased to about 75 per cent by 1965. In 1959, East German boats landed 97,572 tons of fish. In the same year, a further step forward was made when the "Bertolt Brecht," the first trawling and mother ship, and the "Martin Anderson Nexoe," the first transport and mother ship, went into service. At the end of last year, the "Bertolt Brecht" returned from her first 100-day trip to Newfoundland fishing grounds. She brought with her a catch of 11,500 tons, of which 2,500 tons had already been tinned or filleted and deep-frozen during the voyage.

Communications

A new railway station and marshalling yard is being built some three miles south of the commercial port. The station is to be about two miles long and will be the fourth largest in East Germany, Leipzig being the largest. Goods trains will be shunted in the marshalling yards to serve the various docks and the entire railway complex, including lines in the dockyard, will total about 75 miles of track. It will also be joined to the old port of Rostock.

The station is part of the new railway line to Berlin, 155 miles away, to connect with East Germany's main industrial centres. The new line, parts of it already in use and due for completion by 1963, will shorten by one hour the present route via Neubrandenburg and Neustrelitz.

Further communication developments include a new autobahn from Rostock to the Berlin ring, the autobahn circling the former German capital and connecting with other motor roads to the south and to the main East-West autobahn with West Germany via Hanover. This is due to be constructed between 1963 to 1968. Some time after 1965 there is to be a new airport at Roggentin, about three miles east of Rostock, which has no airport at present.

Future planning on a long term basis, from 15-20 years, includes a north-south canal from Rostock to connect with East Germany's industrial centres and the River Elbe. This would make it possible to transport cargoes by water from Czechoslovakia for transhipment at Rostock to deep sea vessels. This trade is at present handled by Hamburg in West Germany.

Economic Developments

Two-fifths of Rostock's living accommodation was destroyed by bombing in April 1942, but rebuilding has made this almost unnoticeable and since World War II the hinterland of the State

(continued at foot of following page)

The Roadrailer

By H. C. W. WESTWOOD
(Pressed Steel Company Ltd., Paisley)

It is common knowledge that in many world ports a current major problem is congestion by road vehicles. From the port operators' point of view and in the interests of the speedy turn-round of ships, it is desirable that traffic to and from the port is divided between road, rail and water in suitable proportions. The proportions are suitable if they throw the right amount of strain on properly organised facilities. In London, for example, congestion could be eased at many berths if more land traffic was rail-borne but even at that important port, as at many others, any dramatic change might call for alterations in the lay-out of a number of berths. When, for many decades, the bulk of consignments passing through transit sheds have been tendered or collected by road vehicle, berth lay-out has naturally been planned with this apparently constant factor in mind.

More than once in post-war years, British Railways have made an effort to capture more traffic and the "Roadrailer" system, which was the subject of a paper read by H. C. W. Westwood (Pressed Steel Company, Paisley) at the London conference of the International Cargo Handling Co-ordination Association in May 1961, is a promising innovation which might in time prove attractive enough to achieve the Railways' aim.

Since his audience consisted mainly of representatives of shipping and kindred interests, Mr. Westwood pointed out in his opening remarks that the Roadrailers could have a direct bearing "on the method of treating containerised and 'roll on roll off' cargoes." After showing a film depicting the experimental use of roadrailer units, the author stated that, if the Roadrailer failed, then we will have witnessed an enterprising attempt in the solution of the age long road and rail co-ordination problem—"but, if it succeeds, as we have every reason to hope that it will, every shipper of goods, large or small, will in the end be affected." Extracts from his paper follow:

(1) History of the Roadrailer Idea

In the early fifties a school of thought had developed on British Railways which maintained that unless a fundamental departure from the existing pattern of railway working is adopted, the Railways will continue to lose, on the grounds of both economics and service, their battle with the Road Haulier. A number of solutions had been tried in the past to the problem of designing a vehicle which could travel both on the road and on the rail. Hitherto the approach had been from the point of view of the rail vehicle being made convertible to a road vehicle. In every case these attempts had failed because of the adverse dead weight added to the vehicle by reason of the heavy members required to enable the wagon to go through marshalling yards and mix with conventional stock, together with such items as buffers and standard couplings which added enormously to the weight of the convertible wagon.

The idea, therefore, gained ground that in order to compete with the Road Haulier it was necessary to adopt his own weapons, and it was decided that the answer lay in adapting the road semi-trailer, with its low dead-weight and high payload factors, to Railway uses.

Simultaneously with the Railways themselves in this country turning towards this solution, the Chesapeake and Ohio Railway in America produced its prototype Roadrailer as far back as 1955. The solution appeared to be a good one and it was in 1957 adopted for development in this country under the guidance of a joint Panel consisting of British Railways, British Road Services and the Pressed Steel Company.

(2) Stage Reached in Development

Two prototype vans complete with their adaptor vehicle have now been built in this country and have been widely demonstrated. They were drastically tested both on the road and on the rail, and have proved themselves to be mechanically sound and durable vehicles. The next stage for the Railways is to prove that this semi-trailer vehicle, the first two-wheeled rail vehicle to be tried in this country, is capable of functioning in train loads. The Railways have taken steps to make this possible, and we may hope that sometime during the early part of next year we will see the first pilot commercial services come into being.

(3) Types of Roadrailer

The Roadrailer, being in basic conception a road semi-trailer type of vehicle, is capable of having the same types of body built on to it as are at present in use on semi-trailers on the roads. The types themselves are based on two fundamental designs, which are:

(i) The Van

This for lightness has a stressed skin body and dispenses with a substantial proportion of stiffening members underneath. Various types of van will fall into this category, that most notable being the refrigerated van.

(ii) The Flat

So far our effort has been concentrated on turning out the van, and in America also the only types running are vans. We are, however, ahead of America in our development of the Flat, and a design has now been produced and work is in hand in building the first two prototypes. When these have successfully passed their tests they will be virtually the basis for all other types of road vehicles such as tippers, open trucks, tankers, pallet vans, etc.

(4) Reasons for our Hopes of its Success

It is obvious that unless we could hope for substantial advantages there would be little point in trying to impose a new system of rail movement on an organisation not without existing problems at the moment.

Basically the Roadrailer comes nearest to a container which carries around with it its own transfer mechanism.

As a Roadway vehicle, therefore, a direct comparison lies with the present system of movement by Containers, and a less direct comparison with the Covered Van, or general merchandise wagon.

Port of Rostock—continued

of Mecklenburg—a predominantly agricultural region pre-war—has been growing industrially. The entire coastline of about 125 miles with a population of about 830,000 and the important towns of Rostock, Wismar, Stralsund and Greifswald has played an increasingly important part in East German industrial reconstruction.

East Germany is at present trading with more than 100 foreign countries, and 50 per cent of all goods reaching the country from overseas is unloaded at ports outside the Republic. About 20 per cent of her foreign trade is exported by sea and up to 1957 about 90 per cent of this trade had to be carried in foreign vessels, which cost the State about 22 per cent of its foreign currency for that year.

By 1965 East German ships will transport four million tons of cargo annually. The Republic has already established regular shipping routes to Russia, Finland, Belgium, the Netherlands, Albania, the United Arab Republic, China, South America—Argentina, Uruquay and Brazil—East Asia and Africa. Other routes are under consideration, including one to the United Kingdom.

(a) Advantages over Containers

The most obvious factor in favour of the Roadrailer is the very great ratio of difference between the deadweight to payload carried by each of these two types of vehicle.

British Railways have standardised on the 4-ton container. It weighs $1\frac{1}{2}$ tons and is carried on a flat weighing $6\frac{1}{2}$ tons, i.e. the payload capacity to tare ratio is 4 to 8 or 1 to 2.

The Roadrailer has a capacity of 11 tons and weighs 5 tons, so that the ratio is 2 to 1 or 4 to 1 when compared with the Flat.

If one converts this to a train of 50 vehicles over a distance of 200 miles—a representative distance in this country—it would mean that the train capacity would be 70,000 ton miles more at a saving of 30,000 ton miles less in tare. If one values the capacity at 2·4d. per ton mile, the value of the additional capacity would be £700 for a single journey without making allowance for the 30,000 ton mile saving in tare.

Turnround

That is one consideration — another is Turnround — The Roadrailer is a road vehicle at each end of its journey and will be turned round as such. On this basis it will have a far faster turnround than a Container, and will do the work of over 5 General Merchandise Wagons, when one takes into account both the turnround and use made of capacity.

Time

I think I need mention only one other factor—Time—At present, except where special express services are mounted, Containers and Wagons suffer from the inherent disadvantage that they lose time in marshalling yards. The Roadrailer is a high speed direct service vehicle, which is not designed to go through marshalling yards.

(b) Advantages over Road Vehicles

From the point of view of the Railway, the main objective of the Roadrailer is to recover for the rail the increasing percentage of traffic that is being carried by road. Unless it can do this its growth will naturally be restricted. What then is its advantage vis-a-vis a high capacity road vehicle.

Its advantage lies in its economics and to a lesser degree over long distances, in its speed.

Economics

The Railway provides the cheapest form of overland transport, so long as the route is direct, the payload adequate, and the distance long enough. It must be evident that one train crew and locomotive should find it cheaper to haul 30, 40 or 50 Roadrailers, than equivalent numbers of road crews and prime movers to haul 30, 40 or 50 road vehicles of equal capacity.

Speed

With regard to speed, all distances between the main Industrial Centres of this country are within a night's journey for Roadrailers, which are designed for rail speeds up to more than 80 m.p.h., so that for distances over 250 miles a speed advantage is expected to lie with the Roadrailer.

(5) Operation of the Roadrailer

We have of course at this stage in its development concentrated on the inland uses of the Roadrailer. These uses are very much those of the Standard Container with an enhanced degree of efficiency and economy.

The collection and delivery by road at either end of the journey is in accordance with normal every day road practice, and it is in the railway operation constituting 90% of the journey, that the main impact of the Roadrailer lies. It is on this operation therefore that I will concentrate. I propose dealing with this subject under the following subject headings: (a) Interchangeability; (b) Attaching and Detaching; (c) Pattern of Services; (d) Station Working; (e) Terminal Operation.

(a) Interchangeability with Normal Stock

It will already have been realised that the Roadrailer does not mix with conventional stock unless it is attached by means of an Adaptor Truck to the trailing end of a train. While this is sometimes regarded with misgiving by conventional railwaymen, those of us who have lived with the Roadrailer would not have it otherwise. The most deadly enemy of speed, and in many cases efficiency, on any railway system is the marshalling yard where the rerouting or regrouping operations are carried out. In particular it will be appreciated that a conventional wagon, or a container on a wagon, can lose days in the last few miles of its journey because it is required to go through secondary marshalling yards for detailed distribution. With the Roadrailer the secondary marshalling yards are by-passed by direct road collection and delivery.

The Roadrailer is intended either to be formed into full train loads or to be attached to the rear end of express goods or passenger trains.

(b) Attaching and Detaching Roadrailers to and from Trains

One of the fundamental advantages of the Roadrailer over normal types of railway wagons is that it can be attached to and detached from any part of a train without the necessity of conventional shunting and switching operations. The operation can be likened to the removal or addition of a wagon on a model railway. The train is divided and the Roadrailer is either removed or added, as the case may be, from or to the centre of the train. This ability means that, although in some cases it may be easier to use switching operations from the point of view of speed, it will enormously facilitate the handling of the loads to be attached and detached at intermediate stations, and will clearly influence the flexibility of the Roadrailer in all normal conditions of railway working.

(c) Pattern of Service

The services for which the Roadrailer are particularly suitable are:

(i) Firstly, the direct through fast goods express with a full load, and averaging 60 to 65 m.p.h. Market research shows that between the main industrial centres in this country there is more than adequate traffic to mount the services.

(ii) Secondly, fast sectional trains with a few block loads for intermediate stations, averaging 50 to 55 m.p.h. The attaching and detaching characteristics of the Roadrailer greatly simplify the work that has to be carried out at the few intermediate stations.

It should also be realised in this context that the number of stations handling goods vehicles can be greatly reduced for Roadrailer traffic, as in order to achieve speed the transfer points can be spaced out and stations between reached by road.

(d) Station Working

Arising out of the two most suitable types of service which I have just mentioned emerges the question of the detailed yard working of the Roadrailer. This is of interest not only to the Railwayman, but also to the freight moving public, because in nothing is the superiority of this vehicle so clearly illustrated as it is in its Terminal Working, which I would like to explain in a little detail.

(e) Terminal Operation

Under this heading, I will deal with the lay-out and pro-

cedure for receiving and despatching a Roadrailer train from a Terminal Station.

Lay-out

In contrast to the massive Reception and Departure Yards for conventional goods stock, one kind of lay-out would have 3 lines and a stabling loop. The facilities required will be :

(i) The track to be concreted to rail top level

(ii) An adequate, and preferably piped, air supply, and

(iii) One, or possibly two (depending on the density of the traffic) spotter tractors per train to transfer the Roadrailers from the park to the track, and vice versa for each direction.

If one allows three minutes for each transfer and parking operation, with two spotter tractors, a train of 50 vehicles could be either completely cleared from the track, or completely formed, according to whether it is an inward or outward train, in a matter of 75 minutes per train. On this basis the theoretical capacity of that small lay-out is 18-50 vehicle trains per day each way, or 900 Roadrailers per day each way.

Procedure—Reception and Departure

With the emphasising of one immensely important feature, the Reception and Departure procedure is logical, completely convenient to both road and rail interests, and is self-explanatory.

(i) Reception. You have here the Goods Agent's dream of a train that on arrival almost literally evaporates off the track. No wagons to be remarshalled for local distribution, no shunting staff or engine power required, no wagons to be placed in goods sidings and no empties to be sorted.

After the locomotive has departed and the Roadrailers have been parked, there will only be the solitary Adaptor Bogie left in the Stabling Loop.

(ii) Departure. Broadly speaking the procedure is the exact converse, and all general remarks made concerning the Reception apply equally. The feature of marshalling, however, without going through a marshalling yard, and without shunting becomes graphically apparent, and assumes its proper importance.

In a through block train no detailed marshalling is necessary; but in all working trains, however few the intermediate stations, the facilities of a collecting yard, a sorting yard, and a departure yard, together with a shunting engine and traffic and locomotive staffs, are completely unavoidable. It must also be apparent that the average time taken to collect a wagon, marshal it, and despatch a train cannot be less than a day—and how often does our own personal experience show that it is more?

Contrast this concentration of manpower and massive equipment with the procedure before you. The Roadrailers are brought and left in the Park. They are also picked out from the Park and placed on the train by the Spotter Tractors **in the marshalling order required,** i.e. it is no quicker forming a train in unmarshalled order than in marshalled order. I hope that one day it may be found possible to assimilate figures to show the enormous savings in cost and equipment.

(6) Roadrailer—Overseas Traffic

I finally wish to turn to Overseas Traffic, and in doing so to pass brief comments on Rail and Road Ferry potentialities, and Containerised Cargo.

I have endeavoured to present to you a picture of what the Roadrailer is, and how it will function in a domestic role. With regard to Overseas Traffic, I can do no more than to suggest very briefly indeed elementary questions which occur to me, and with which many of those here will no doubt be extremely familiar, as they are already present with existing types of vehicle.

Firstly, the Roadrailer is capable in itself of carrying its payload on board ship either in the capacity of a Rail Ferry Wagon or a "roll on roll off" road vehicle.

(a) A Ferry Wagon—On Rail

If the Roadrailer is suitable for traffic conditions in this country, it will be equally suitable on the Continent. It is conceivable, however, that in spite of the interest displayed by Continental Railways, its first practical use there might be on traffic emanating from this country—this also applies to Ireland. For instance two such cities as London and Paris might well find themselves able to set up direct and economical Roadrailer services, especially in the economic climatic changes which may eventually be brought about by the Common Market or the Channel Tunnel project.

(b) As a "Roll on, Roll off" Road Semi-Trailer

In this role it will be capable of utilising Ferry capacity as a road vehicle, and could bring a door to door service within the direct reach of interests with regular traffic to points near the port of disembarkation.

Secondly, the Roadrailer will have a function as a Container carrier. I suggest that this might effect cargo handling in one or other of the following ways.

(a) It will allow containerised traffic to be brought alongside either by road or rail. I suggest that the normal method would be by road, the system, which presupposes a measure of ship's containerisation, being somewhat as follows :

A train would arrive at a Roadrailer transfer point containing Roadrailers for local destinations as well as overseas. The overseas traffic might be intended for several different ships. Using the procedure already described the vehicles would be taken simultaneously by road to their various destinations, and could all reach there within two hours of their arrival at the transfer point.

(b) It will provide a rail vehicle to permit containers of up to 10 tons capacity to be brought into general use. This of course poses the handling and cranage problem.

The large capacity containers should have a particular application for refrigerated cargoes, especially insulated containers of plastic sandwich construction, which appear at this stage to be particularly suitable for use with Roadrailers.

Summary

May I now summarise the main points I have made.

By the end of the year, it is expected that there will be sufficient Roadrailers in existence for a commercial service to be mounted. The types divide themselves into those based on the Van design and the larger number of varieties based on the Flat.

The advantages over Standard Containers are (i) they lie in the 4 to 1 payload to tare ratio, when compared with the Container; (ii) the very large increased turnround of the Roadrailer and (iii) the journey time factor.

The advantage of the Roadrailer over road vehicles will lie in its direct operating economics. The operation of the Roadrailer will show enormous economics at (a) the terminal and (b) intermediate stations. Particular attention is drawn to the Reception and Departure Procedures at Terminal Stations.

As far as overseas traffic is concerned, there will be implications both for containers and "roll on roll off" types of cargo handling.

May I conclude by expressing the hope that, by this time next year, we will have a chance to see the pattern begin to unfold before us.

Advantages of the "Historical" Method in Mobile-Bed Model Testing

Application to the Seine Estuary

By JEAN CHAPON

Introduction

The problems associated with the operation of the Port of Rouen have for centuries been dominated by the maximum draught imposed on vessels by the approach waterways to the port and, in particular, by the River Seine, whose channel is unstable and shallow.

Under an Act passed in 1932 approval was given to a preliminary improvement scheme which aimed at establishing in the Seine Estuary a stable and suitably regulated channel which was to have depths 2—3 m. greater than those which had hitherto existed.

Before carrying the scheme into effect—at an estimated cost of around twenty milliard "old" francs (value as in 1959)—the Port of Rouen, the promoting authority, wanted to obtain adequate assurances that the scheme would indeed be successful. It accordingly commissioned the organisation bearing the name of Sogreah* to carry out extensive tests on hydraulic scale models in their laboratory. In these tests the so-called "historical" method of investigation was applied in determining certain factors which it had not been possible to evaluate even by the most meticulous techniques previously employed.

Broadly speaking, the improvement scheme for the Seine Estuary envisages the connection of the fluvial part, situated upstream of the Risle (a tributary) and flowing between dykes, to the maritime part of the estuary, by the provision of a transitional zone in which the conditions of hydraulic flow and the transport of solids would establish a state of stable equilibrium.

The theoretical investigation of the problem was not amenable to rigorous mathematical treatment on account of the multiplicity and complexity of the natural phenomena involved (tides, swell, etc.), their regular or random character, and the investigators' ignorance of the physical laws governing them. Besides, it was not possible to draw valid conclusions for deciding the features of the proposed new training works from the observation of the natural phenomena and the effects of earlier works of this kind. Hence it was a logical step to build and test a scale model of the estuary.

The Model and its Problems

What the model was required to do was to confirm the effectiveness of the training works to be constructed under the provisions of the 1932 Act, to yield precise information on the navigability of the new channel and, especially, to predict the evolution of the depths of the channel over a period of some decades.

It was therefore necessary to build a mobile-bed model that would enable a check to be kept on the changes occurring in the water depths and would show how much time the new channel would require for achieving stabilisation. The time scale for the evolution of the channel bed accordingly had to be determined. This constituted at once the most important and the most difficult problem of all.

The natural factors affecting the configuration of the bed were numerous and complex (tidal heights and currents, swell, river discharge, bed material, salinity). Inasmuch as the physical laws

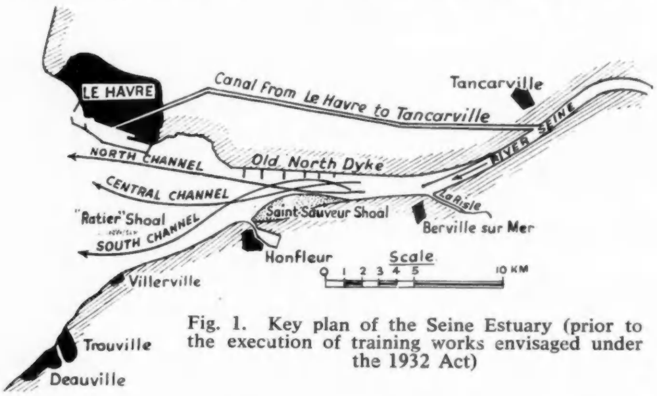


Fig. 1. Key plan of the Seine Estuary (prior to the execution of training works envisaged under the 1932 Act)

governing the action of natural factors on the beds of water-courses are only imperfectly understood, it was a difficult matter to know in advance which of these factors could be neglected and which were essential to the extent of having to be reproduced in the model. For obvious technical and financial reasons, however, certain factors (Coriolis force, transport of mud, salinity) were neglected from the outset.

Finally, the choice of material to be used for the bed of the model had to be determined by means of preliminary tests, though

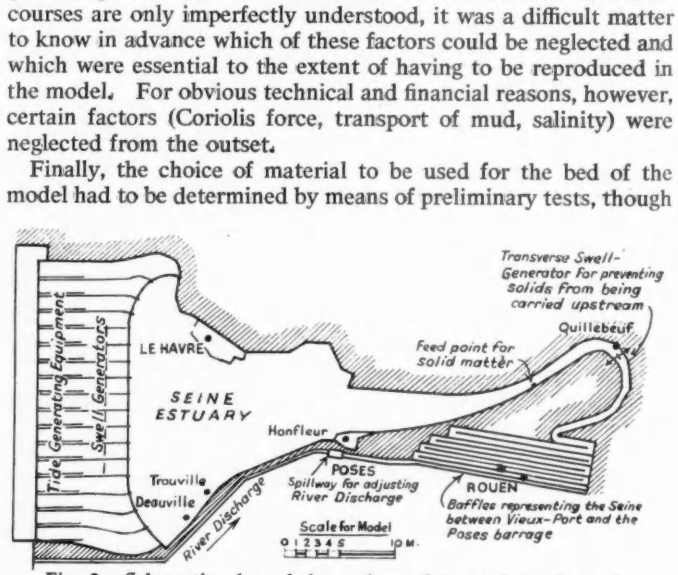


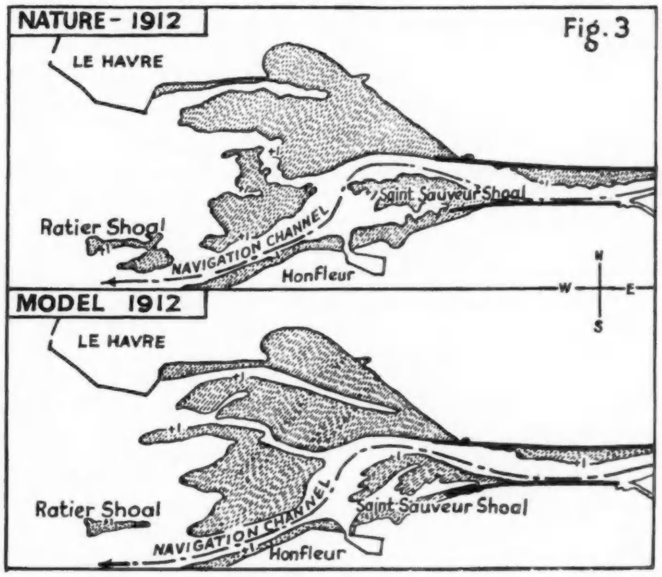
Fig. 2. Schematic plan of the scale model tested by Sogreah.

one could not be sure that the law governing the movement of solid matter in the model was indeed representative of the actual conditions in nature. The construction of the scale model thus presented some very awkward problems, both at the theoretical and the practical level.

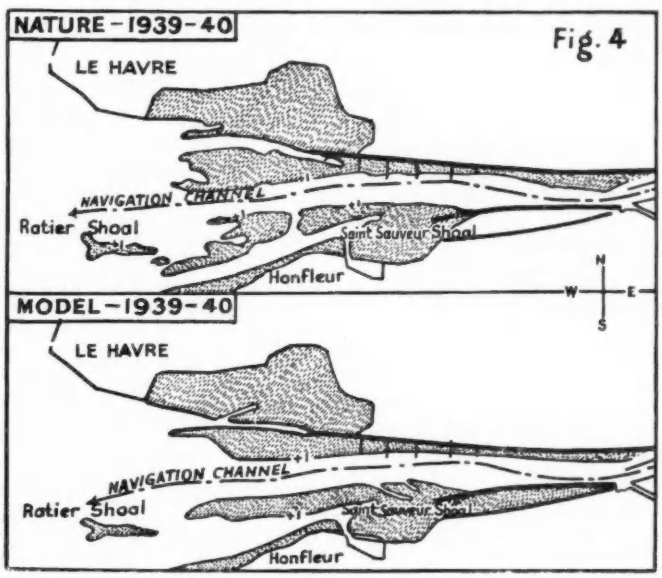
*Formerly styled Société Neyrpic, Grenoble.

The model represented the Seine Estuary between the meridians of Villers-sur-Mer and Quillebeuf and was constructed to a 1/800 horizontal and a 1/100 vertical scale. The hydraulic time scale was 1/83·3. The bed material consisted of rather fine sawdust (Fig. 2).

Scale models can theoretically be proved by the application of



the rules of similarity to the equations of the natural phenomena for which the mathematical expressions are known but whose boundary conditions or initial conditions are complex and ill-defined. In the case of the Seine Estuary it was possible, with reference to the river discharge and the propagation of swell and tides, to determine the hydraulic time scale (t) as a function of

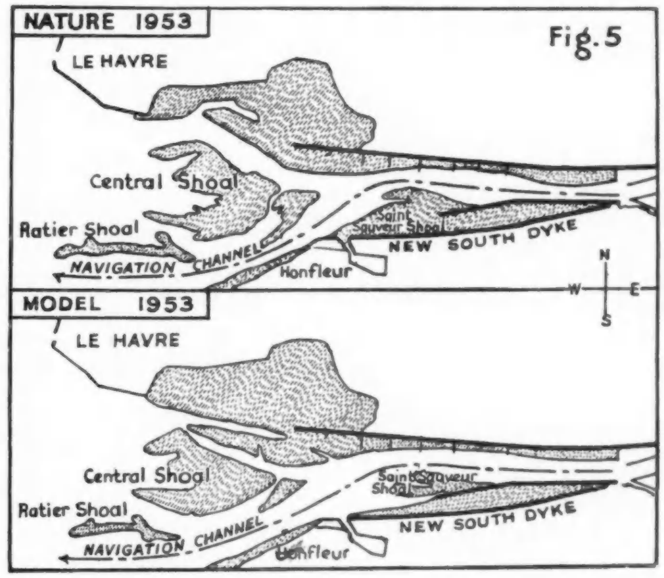


the horizontal scale (l) and the vertical scale (h), viz.: $t = l/h^{1/2}$.

The vertical exaggeration (or width diminution) was determined from the overall similarity condition for reproducing the configuration of the bed, in conjunction with a consideration of Lacey's laws and the "fineness" of the configuration. Theoretical considerations on the transport of solids (Einstein's theory) and on frictional similarity made it possible to reproduce the whole set of actual movements of solid matter occurring in reality merely by the movements of the solid bed material. No theoretical considerations could, however, provide a means of ascertaining the time scale for changes in the configuration of the bed. There were no grounds for assuming in advance that this scale must necessarily be the same as the hydraulic time scale.

The western boundary of the model was provided with a tide-generating device which was so adjusted as to reproduce the tide curve with a coefficient of 95 at Le Havre. This considerable simplification was by no means an arbitrary one and was based on the preponderance of the action of tides with high coefficients, as had been confirmed by the preliminary tests with the model. The swell was likewise simplified, and its action was limited to the role of a catalyst for bringing about the transport of materials that it plays in nature. The discharge of the river was made equivalent to a flood of 1200 m^3/sec. for a period of 9 model-hours and to a dry-weather flow of 250 m^3/sec. for 18 model-hours.

Finally, although the model reproduced the characteristic phenomenon constituted by the long-term accretion occurring



in the estuary at an average rate of 3 million m^3 per year, it was necessary, for technical reasons, to locate the point of entry of solid matter upstream of the Risle, so that the model did not take account of the marine origin of the accretionary matter deposited in the estuary.

Thus, the extreme simplification of the natural phenomena reproduced in the model was quite a remarkable feature. Indeed, the investigators realised full well that, in order to be able to place full confidence in the results yielded by the experiments, it was necessary to employ a more advanced degree of preliminary adjustment and proving than that which is normally employed.

The "Historical" Tests

The initial adjustment of the model consisted in reproducing the bed conditions, the water levels and the currents that occurred in 1947. On the strength of these observations it was possible to make a choice of the bed material, to adopt a value of 8 for the vertical exaggeration of the model, and to perfect the experimental technique.

It was not, however, possible to deduce from the reproduction from one particular set of conditions the values of the criteria used for making these adjustments, nor the time scale for changes

in the bed configuration. Besides, the 1947 situation was not a stable one, and the only way to ascertain whether such instability was due to a fault in the model or whether it, alternatively, reflected what was actually taking place in nature, was to study it in relation to time and compare it with known situations which had occurred in reality. The "historical" tests were therefore a natural sequel to the conventional adjustments of the model.

At first sight, the examination of the positions of the channel in the Seine Estuary might appear to be a rather haphazard procedure. This phenomenon is, however, found to display a periodicity of the order of 18 years during which time the channel swings from a southern to a northern position via an intermediate position. This did not mean that the historical investigation of the estuary could accordingly be limited to a cycle of 18 years. Actually what the Port of Rouen wanted to verify was the effectiveness of the proposed training works over a period of some 50 years, and so it seemed reasonable to require an equivalent length of time in respect of the reproduction of past conditions. The Port had annual hydrographic surveys since 1864 at its disposal; by selecting a test period from 1875 to 1953 it was possible to study the evolution of the free estuary (1875-1895), then the effect of early training works (1895-1925), and thereafter once again the free estuary in the presence of old training works.

The first series of historical tests was carried out in 1955; it related to the period 1869-1953. As soon as the model was put into operation, the bed began to undergo rapid changes, and a very accurate reproduction was obtained of what actually occurred in nature. Determinations of the cubature (tidal volume) made between 1870 and 1890 revealed an annual accretion of 5 million m^3 and provided the means of adjusting the rate of feed of solids to the model.

Throughout the 1870-1890 period the model reproduced the periodical variations of the channels, which constituted a natural process displaying a cyclic behaviour.

The construction of the south dyke between the Risle and the region of Honfleur gave rise, in 1906-1907, to the formation of the shoal named Saint-Sauveur whose outline on plan has undergone various fluctuations, which were reproduced by the model. The groynes projecting from the north dyke, which were built between 1923 and 1925, caused the channel to move southward. Previously the channel had become stabilised along the north dyke upstream of Honfleur. Thereafter the situation first evolved to a central channel (1939) and subsequently (1953) became stabilised on the south side of the estuary.

The model reproduced, in an orderly manner, not only the overall evolution of the main and secondary channels, but also the "micro-evolution," the relatively minor changes, which were likewise very faithfully represented.

Three years after the first series of historical tests a second series was carried out (in 1958), relating to the period from 1906 to 1922. Right from the start of this test series the formation and subsequent growth of the Saint-Sauveur shoal manifested itself. The bends in the channel were reproduced according to the same pattern and displayed the same evolution with the passage of time as did those of the actual channel.

The historical tests yielded the main information that the investigators were seeking, namely, the time scale for the evolution of the bed configuration. This was found to be 1/876 (i.e., 10 model-hours to one natural year, or 60 model-tides to one natural year). The subsequent tests then acquired considerable value, inasmuch as the length of time during which the training works would remain effective could now be predicted, as also the transitional period necessary for the stabilisation of a channel along a new course, and the rate of dredging operations. The model had thus, indeed, become a veritable precision measuring instrument, despite the considerable simplification that had been introduced for technical and financial reasons.

The tests also revealed the sensitivity of the model. This was evident not only from the accuracy with which the bed configuration was reproduced, but also from certain events that occurred during the tests. Thus, in the course of the second test series, it was found that around the year 1914, contrary to what had actually occurred in nature, the channel in the model assumed a very stable position along the north dyke and that the initiation of a new path of flow through the central shoal area was encountering difficulty. An inspection of the model showed that the north dyke had inadvertently been extended too far downstream for a distance of rather more than a kilometre. On removal of this excess length, the channel at once cut through the shoal and the situation thereafter continued to develop in accordance with reality.

The success of the historical tests has not only confirmed the validity of the simplifications adopted in representing the phenomena, but it has also provided a check on the boundary conditions; the relative constancy that was imposed on these conditions by the need for reproducing the tide curve for Le Havre in no way hampered the natural evolution of the bed in the estuary.

It must be emphasised that the success achieved with the "historical" testing procedure was no mere lucky accident. On the contrary, the preliminary adjustments carried out on the model enabled the historical tests to be undertaken with the maximum prospect of success. The choice of the bed material, in particular, was determined by reproducing the break-down of a channel by simultaneous deterioration of its downstream outfall and of its curved profile in the Honfleur region. These factors were determined *before* the historical tests were carried out, and it was not found necessary to make further corrections during these tests. The success of the tests was therefore predetermined by the investigations and adjustments that preceded them.

Conclusions

The "historical" method thus provides the means of perfecting the adjustment of a mobile-bed hydraulic model and of determining the time scale for the changes in the configuration of the bed, which cannot be calculated on the basis of theoretical considerations nor by adjustment to permanent flow conditions. In the case of the Seine Estuary model the historical approach confirmed the validity of the boundary conditions and the accuracy with which the natural phenomena were reproduced.

In this connection it should be noted that the notions of "past" and "future," in terms of the model experiments under consideration, are conventional ones. Thus, if the situation in, say, 1913 is called "the present," then the model can be said to have correctly reproduced forty years of the "future" as well as forty years of the "past." Hence there is no reason *a priori* why the origin of the time scale should not be shifted to 1953 and why the accuracy obtained in respect of the past forty years should not provide a sound basis for assessing the efficiency of projected engineering works over a future period of equal duration.

Finally, the historical method enables us to study natural laws under more favourable conditions than are provided by the observation of "full-size" phenomena, which are often distorted or obscured by the human factor or by fortuitous variations.

The experience gained with the hydraulic scale model of the Seine Estuary shows the historical tests to be the natural sequel of the conventional procedures for measuring natural phenomena and effecting meticulous adjustments. Besides, the study of this estuary is not the only instance of the successful application of this method. What makes this case so interesting, however, is the length of time covered by the investigation and the generality of its scope.

Bulk Sugar Terminal At Georgetown, British Guiana

General Description of New Facilities Provided

(Specially Contributed)

A TERMINAL for shipping raw sugar in bulk to ocean-going vessels has recently been brought into full operation at Georgetown, British Guiana; the terminal is located on the east bank of the Demerara River and is owned and operated by Demerara Sugar Terminals Ltd., of which 80% of the share capital belongs to Booker Bros. (Liverpool) Ltd. (a member of the Booker Group of Companies), and the remaining 20% belongs to Sandbach Parker and Co. Ltd., a subsidiary of the Demerara Company Ltd.

Simon Handling Engineers Ltd. of Stockport, England, working in conjunction with the staff of the Booker Group were responsible for the complete design of the mechanical handling plant and structures and supervised the erection and commissioning.

The terminal is capable of loading out sugar to ship at 500 tons per hour, taking in from barge or coaster at 200 tons per hour and taking in from road vehicles at 100 tons per hour. These three functions can be performed simultaneously if necessary. Provision is also made for the transfer of sugar at a rate of 200 tons per hour between two large store buildings having a combined capacity of 40,000 tons.

System of Operation

The block plan (Fig. 1) shows the layout of the terminal, which performs the following functions.

Sugar brought from the factories by road vehicles is carried in containers and is tipped into an intake hopper at the road intake house. This hopper discharges on to an inclined conveyor which carries the sugar to the top of a junction tower for delivery to either of the two stores.

Sugar brought by coasters and barges is unloaded at the river intake jetty as indicated at the top left of the plan. The river intake structure has two fixed booms extending over the berth for barges on the landward side of the jetty and two hinged booms extending over the berth on the river side where coasters can be accommodated as well as barges. A traversing crab with grab operates on each pair of fixed and hinged booms. Each grab discharges into a hopper in the base of the unloader structure from which sugar is transferred by a conveyor to a transfer house supported on a nearby dolphin. Here the sugar is transferred to the tail end of a long inclined conveyor which carries it to the top of the weigher tower situated to the river side of the two stores. After being weighed the sugar is carried by an inclined conveyor from the base of the weigher tower to the top of the junction tower and from this point it is delivered into either store by means of steel band conveyors in the same way as sugar delivered by road. Distribution of the sugar inside each store is effected by means of mobile ploughs which divert the sugar from the steel band conveyor at the desired points.

For shipment, sugar is reclaimed through openings in the floor of each store on to centrally situated belt conveyors delivering to the base of the junction tower. It is then conveyed to the top of the weigher tower, weighed and discharged through a hopper on to the long inclined conveyor which delivers to the mid point of the loading-out gantry. Here it is transferred by means of bifurcated chute to both or either of two shuttle conveyors, each feeding a loading-out conveyor, one on the south span of the gantry and the other on the north. This arrangement enables sugar to be loaded to two hatches of a vessel simultaneously. Each loading-out conveyor is carried in a retractable boom carried in a travelling crab, and the telescopic chute at the end of each conveyor is thus capable of being positioned over any point of the hatch opening, so that the necessity for trimming the cargo is greatly reduced. When either chute is being repositioned to deliver to another hatch, the full flow of sugar can be temporarily diverted to the loading-out chute on the other span of the gantry. In this way loading can continue uninterrupted at the maximum rate whilst the loading chutes are being moved.

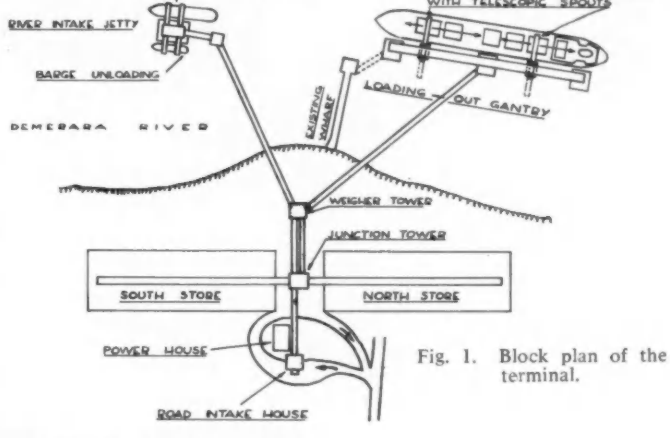


Fig. 1. Block plan of the terminal.

The Switch to Bulk Handling

In 1955 it was recognised that the construction of a bulk sugar terminal in British Guiana would soon be necessary to satisfy the requirements of refiners in Great Britain and Canada who had already installed facilities for receiving and storing sugar in bulk instead of in bags. Prior to this date all sugar from the estates in British Guiana was bagged at the factories for transportation to the wharves of Georgetown. Here it was either shipped in bags or, as became increasingly necessary, the bags were slit and the sugar was "bled" into the ships' holds. This unsatisfactory method of handling, coupled with the frequent congestion of the wharves, which are not modern and which handle all types of cargo as well as sugar, limited the average loading rate to not more than 100 tons per hour when working into four or five hatches simultaneously.

A logical consequence of the decision to construct a bulk sugar terminal was to initiate a form of shipping which could make full use of the advantages which such an installation had to offer and

furthermore to co-ordinate its design closely with that of the ship-loading facilities of the new terminal. The first fruits of this policy are to be seen in the "Booker Venture," a bulk carrier which made its maiden voyage earlier this year not long after the bulk sugar terminal came into operation.

A basic factor governing the design of the "Booker Venture" was the extensive bar at the mouth of the Demerara River. During the normal 29-day tide cycle over this bar there are only two periods of a few days each when the depth of water exceeds 19-ft. Despite the maximum draft imposed by the bar the "Booker Venture" is able to be loaded with a part cargo of 7,000 tons of sugar from the terminal and will be filled up elsewhere. Very large hatches with single-pull steel hatch covers powered by the ship's winches, combined with the rapid loading facilities afforded by the terminal, permit a very quick turn-round to be achieved. As the shipment of sugar is seasonal and limited to the spring and autumn, the "Booker Venture" has not been designed solely as a sugar carrier and it is interesting to note that through an ingenious design of the wing ballast tanks she can be easily adapted for use as a grain carrier.

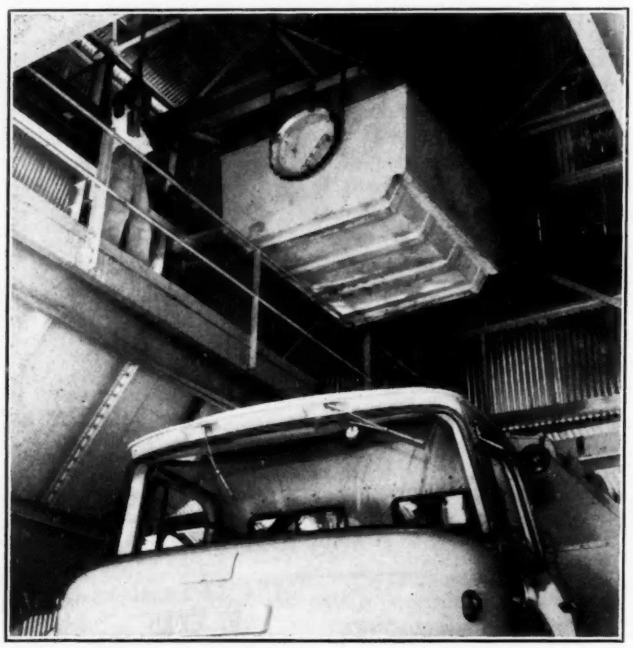


Fig. 2. Hoisting a container from a lorry in the road intake house.

DETAILS OF MECHANICAL HANDLING EQUIPMENT

(i) **Road Intake** (Fig. 2)

The road intake house accommodates an overhead travelling crane and an intake hopper of 16-ton capacity. A through way is left to allow lorries to drive in and out of the building without reversing. There is an intermediate platform at hopper-top level with a well opening through which the sugar containers are hoisted from the lorry. The 10-ton crane is fitted with twin 5-ton hoist units mechanically coupled by a roller-link chain, and is controlled from the platform by means of a suspended push-button station. Demerara Sugar Terminals Ltd. were responsible for the supply of the sugar containers and of the container tipping mechanism. A 4-in. steel mesh grid is fitted to the hopper opening to prevent the entry of large foreign matter on to the inclined conveyor which conveys the sugar to the top of the junction tower for distribution to store.

(ii) **River Intake** (Fig. 3)

The river intake house accommodates two unloaders at 30-ft. centres. Each unloader has a fixed boom on the landward side of the jetty for unloading barges, and a hinged boom on the river side for unloading coasters. When not in use each hinged boom is luffed into a near-vertical position by winch gear located near the top of the intake house structure. This leaves the shipping lane clear and allows the departure and arrival of coasters at the berth without obstruction. The two boom winch-gear houses are connected by a walkway.

Each unloader incorporates a travelling crab running on tracks carried on the booms. Each crab is of the three-motor type and is suitable for a normal working load of four tons including the weight of the grab. The operation of the crab and grab is based on a cycle of 60 seconds for loading the grab in the coaster's hold, hoisting the grab, traversing the crab to the intake hopper, unloading, traversing back and lowering for the next load. The grab load of 75 cu. ft. allows a capacity of from $1\frac{3}{4}$ to 2 tons of sugar. The peak loading rate is therefore in the order of 210 tons per hour for both grabs together.

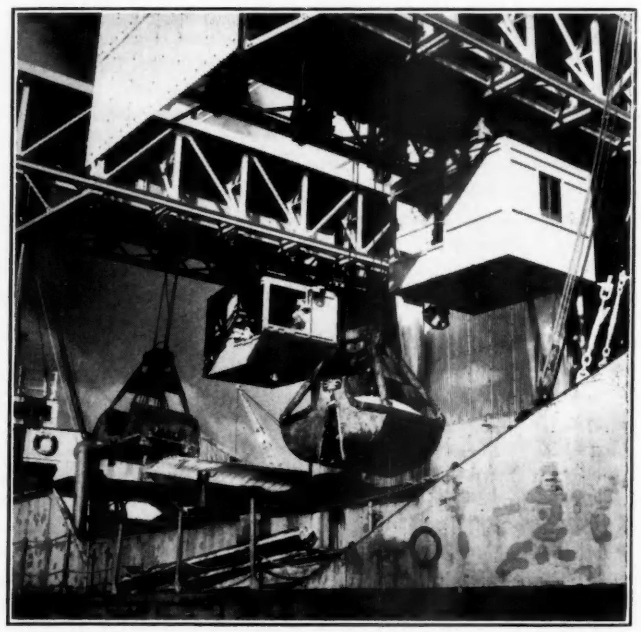


Fig. 3. Travelling grabs operating on a coaster at the river intake.

The grab hoisting motion consists of two independent systems of gears and rope barrels, each barrel being electrically driven through gearing. The crab traverse is effected through first and second reduction gears from an electric-motor drive. The grabs are of the four-rope type to minimise grab spin.

An operator's cabin is suspended under one end of each crab frame. Each cabin is of open construction providing good all-round visibility and has a flood-light fitted beneath it to illuminate the grab, hold and hopper.

The fixed and hinged booms of the unloaders are fitted with curtains of toughened fabric which can be closed to give protection against adverse weather conditions.

Each of the grabs is emptied into an intake hopper from which the sugar is delivered through a feed-on chute on to a conveyor. This conveyor runs at first horizontally and then at a slight incline to a transfer house built on a mooring dolphin adjacent to the intake jetty. Here the sugar is transferred to a 365-ft. long inclined conveyor which delivers it direct to the weigher tower.

(iii) **Weighment and Distribution** (Fig. 4)

The weigher tower houses two Servo-Balans weighers, one of 500 tons per hour capacity and the other of 200 tons per hour, supplied by Demerara Sugar Terminals Ltd.

Sugar brought by conveyor from the river intake is delivered through chutes into the 200 tons per hour weigher. After the weight has been recorded the sugar is deposited into a 6-ton capacity collection hopper. From the outlet of this hopper it passes through a feed-on chute with a hand-operated adjustable control gate to a conveyor which delivers it to the top of the junction tower. From this point in the system the same equipment is used for distribution to store whether the sugar is brought in by road or river. A bifurcated discharge chute located in the top of the junction house and fitted with a power-operated two-way gate is used to route the incoming sugar to either the north or south store.

Each of the steel band conveyors for distribution of sugar in the stores runs at a slight incline from the junction houses and then horizontally along the apex of the store roof. Two mobile plough-off units are provided in each store, propelled by hand winching gear, for diverting the sugar into store at the desired points. The units have adjustable radius ploughs and each pair of units is able to divert all or part of the band load, any remaining part of the load being delivered over the head pulley.

The two steel-band conveyors in the stores are the only conveyors of this type in the terminal, all the remainder being troughed belt conveyors. One of the reasons for choosing steel-band conveying in combination with the ploughing-off method of distribution in preference to the troughed belt and throw-off carriage combination, was because the latter method involves contact between pulleys and the load-carrying side of the belt, which was considered unsuitable in this instance because of the sticky nature of the material being handled.

(iv) **Reclamation and Loading-out** (Fig. 5)

Reclamation of sugar from the stores for loading out is basically by means of gravity through floor openings, mobile reclaiming machines provided by Demerara Sugar Terminals Limited being employed to assist the flow of sugar through the openings when necessary. There are fifteen outlets along the centre line of each store, each with an opening of approximately 11-ft. by 9-ft., an outlet hopper and an outlet frame incorporating a series of hand-operated louvres by which the movement of sugar on to the reclaiming conveyor can be controlled. The sugar is loaded on to the belt through mobile feed shoes, of which there are four to each store. Each mobile feed shoe is mounted on a carriage running on rails which form part of the conveyor steelwork and is hand-propelled. The outlet from the feed shoe is complete with side guides and an adjustable profile plate which controls the load of sugar carried away by the conveyor.

Sugar is delivered by the two reclaiming conveyors into a common discharge chute at the base of the junction tower on to an inclined conveyor leading to the top of the weigher tower. Here the sugar passes through chutes into the 500 tons per hour Servo-Balans weigher and after weighment into a 10-ton capacity collection hopper. From the outlet of this hopper it is fed on to the 475-ft. long inclined shipping conveyor leading to the mid point of the shipping gantry.

The shipping gantry is of lattice girder construction and is supported on one central and two end towers so that there are two clear spans (north and south) of 177-ft. each. The lower sections of the three towers are of portal construction to allow headroom for vehicles on the jetty roadway. The central tower supports the upper extremity of the shipping conveyor gantry, and also carries the shipping control cabin with box windows which command an unrestricted view of the whole length of the jetty.

Fig. 4. The Servo-Balans weighers in the weigher tower.

Sugar is delivered over the head pulley of the shipping conveyor into a bifurcated chute with a power-operated gate. The gate can be set for delivery of sugar on to both or either of two shuttle conveyors, one in the north span of the shipping gantry and one in the south span. Each shuttle conveyor is mechanically connected with a travelling crab running on rails forming part of the gantry structure. The crab carries an extendable and retractable loading boom on which is supported a further shuttle conveyor running at right angles to the first, and receiving the sugar from it. This conveyor can be extended to deliver the sugar at a maximum of 64-ft. 6-in. and retracted to deliver it at a minimum of 16-ft. 6-in. from the centre line of the shipping gantry. The sugar is delivered into the ship's hold from the second shuttle conveyor through a telescopic chute consisting of aluminium sections and suspended vertically from the end of the retractable boom. It will be seen that by virtue of the 160-ft. range of movement of the first shuttle conveyor along the shipping gantry and the 48-ft. range of movement of the second shuttle conveyor transverse to the gantry, sugar can be delivered at any point within an area of 7,680 sq. ft., over a vertical range of approximately 50-ft. provided by the telescopic action of the delivery chute; in other words, through any part of a ship's hatch at the most suitable height above the bottom of the hold.

A winch mounted in the central tower of the shipping gantry provides the motive power for the long travel of each crab and its associated shuttle conveyors at a speed of 25-ft. per minute.

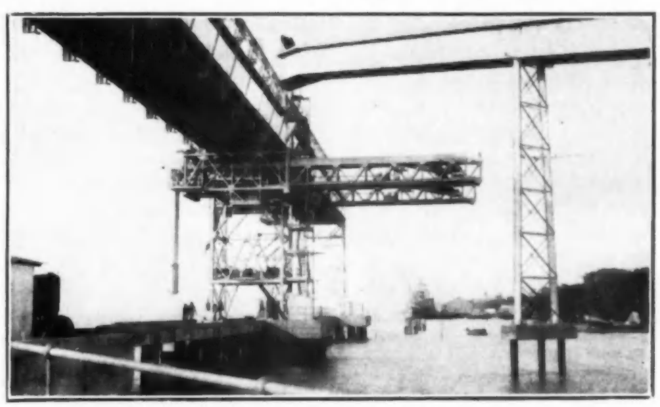


Fig. 5. View of the shipping gantry from jetty level.

A winch carried in the travelling crab retracts and extends the loading-out boom, the winch drum operating continuous ropes attached to each end of the boom frame.

Winch gear is mounted in the loading-out boom structure adjacent to the drive for the secondary shuttle conveyor to extend and collapse the telescopic loading-out chute. The secondary shuttle conveyor is protected at the sides by aluminium alloy wind shields and on top by collapsible toughened fabric covers arranged so that the cover over the front section of the conveyor is extended when the one at the back is collapsed, and vice versa.

(v) **Conveyors**

Nominal conveyor speeds are 300-ft. per minute for the road and river intake as far as the junction tower, 380-ft. per minute for the steel-band store distribution conveyors, and 350-ft. per minute for the reclaiming, shipping and loading-out conveyor line.

All troughing sets are of the sealed-for-life type, requiring no attention. The return idlers are designed to prevent the build-up of sugar and consist of hard rubber discs mounted on a steel roller. The build-up of sugar is also prevented by snub and diverting pulleys of the fabricated-cage type fitted at suitable positions.

Fig. 6. View in conveyor gantry showing continuous illumination and ventilation slot between top of wall and overhanging eaves.

Tensioning gear on the conveyors is variously of the screw type and of the automatic deadweight type. On the reclaiming conveyors and the conveyor between the weigher tower and the junction tower the deadweight tensioning is at the tail end and the tail pulley is mounted on a moving carriage.

All the belt conveyors are fitted with an adjustable steel scraper and with either a pair of rotary nylon brushes, electrically driven through a chain transmission or a single brush of the same type, chain driven from the head pulley.

(vi) **General Features of Construction** (Fig. 6)

Because of its resistance to corrosion, heat-reflecting characteristics, ease of maintenance and generally attractive appearance, corrugated aluminium sheeting has been extensively employed throughout the terminal as a roofing and cladding material for the weigher and junction towers, conveyor gantries, and the other structures.

The light-reflecting characteristics of aluminium have been exploited by leaving a gap between the upper edge of the wall cladding and the roof on all structures, to provide illumination by reflected natural light. This arrangement also assists natural ventilation. Weather protection is ensured by a generous overhang on all eaves.

Corrugated perspex lights have been employed at various points as well as windows of the conventional type, and additional ventilation is provided where necessary by louvred construction in aluminium sheeting.

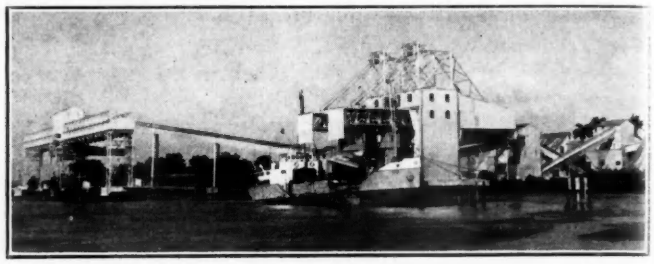


Fig. 7. The terminal viewed from the Demerara River, with the coaster Karani unloading at the river intake in the foreground.

(vii) **Electrical and Control Equipment**

The main switchboards for the terminal are located in a control room in the junction tower. Also located in this control room is a panel for controlling the shore conveyors and this panel has a mimic diagram fitted with indicator lights to show which conveyor is running.

A starter board and a control panel with mimic diagram for the bifurcated chute gate and the four shuttle conveyors are located in the control cabin in the central tower of the shipping gantry.

The crab travel and loading-out boom extending and retracting motions in each span of the shipping gantry are controlled from either of two duplicate push-button stations.

A 25-line telephone panel with eighteen telephones is provided for intercommunication between various points of the terminal.

All the electric-motor drives in the terminal were provided by Demerara Sugar Terminals Ltd. to the specification of Simon Handling Engineers Ltd.

Mechanisation on Sugar Estates

Simon Handling Engineers Ltd. have also designed and supplied mechanical handling equipment for Bookers Sugar Estates Ltd. at seven of their estates in British Guiana. These bulk handling facilities will enable full use to be made of the new terminal at Georgetown.

Traffic at East African Harbours in 1960

According to the annual report of the East African Railways and Harbours Administration for 1960, both earnings and tonnages handled at the ports last year were the highest recorded. The bulk of the overall increase in tonnage passed through Mombasa and Dar-es-Salaam, with imports of oil showing a marked growth. At Mombasa, general cargo exports amounted to 879,000 deadweight tons, an increase of 23,000 tons over 1959. General cargo imports, at 625,000 tons, were up by 29,000 tons and imports of bulk oil rose substantially by 45,000 tons to 1,024,000. Other miscellaneous traffic handled at Mombasa brought the total cargo to 2,651,000 deadweight tons, 83,000 more than in 1959.

General cargo exports through Dar-es-Salaam improved by 52,000 tons to 351,000—a new record for the port, and general cargo imports, at 246,000 tons, were 27,000 tons greater than in 1959. Bulk oil imports also rose, by 13,000 tons to 235,000. Total tonnage handled at the port was 832,000, 91,000 more than the previous year.

Although there was a marked falling off in general cargo imports handled from 37,000 to 27,000 tons, increases in bulk oil imports (4,000 tons) through Tanga, and general cargo exports (3,000 tons) did much to offset the decrease. The total tonnage handled at Tanga during 1960, at 199,000 was therefore only 2,000 tons below that of 1959

Depredation of Timber in Marine Construction

I.—Marine Borers (with particular reference to their distribution in U.S.A. waters)

By SHU-T'IEN LI, Ph.D., F. ASCE, M. PIANC*

This paper, which is being published in two parts, classifies damage to timber in marine construction; presents details of biological damage with reference to vertical variance, latitudinal extent, and geographical distribution; discusses decay, insect, and marine-borer organisms, and their mechanisms of attack; describes physico-chemical, meteo- and hydrophysical, geophysical, mechanical, and treated-timber damage, fire hazards, and damage due to improper design, construction, maintenance, and operation.

Among the physical, chemical, biological and other causes of damage to timber in marine construction, three of the more serious are due to decay, attack by marine borers, or by other insects. All damage to timber in marine construction, three of the more serious

The infestation of borers in different localities has been constantly changing with time as conditions become favourable or unfavourable for their existence. Past or present absence or inactivity, however, does not indicate that the waters are immune; a sudden infestation may cause the failure of waterfront structures, such as happened in the upper part of San Francisco Bay in California, which was considered free from marine borers for many years.

Marine borers were only noticed in Boston and other New England harbours as recently as 1933. *Chelura* had not shown any significance in the coastal waters of the continental United States until 1935, when it appeared in enormous numbers in Boston and several other New England harbours. By 1937 a significant infestation of marine borers had occurred on the North Atlantic coast of North America, when (1) the attack of *Limnoria* on test boards had 2 to 10 times increase over previous years in Newfoundland, Nova Scotia, and New Brunswick ; (2) the teredine activity increased greatly in New England waters south of Cape Cod where the most destructive borer had been *Teredo navalis*; (3) *Teredo* was found in destructive numbers in harbours previously regarded as immune, from Newfoundland to northern New England ; and (4) *Teredo tryoni* and *Teredo dilatata* caused considerable damage in New England harbours where their activity had never been recorded previously. In the following years of 1939 to 1941, *Teredo* and *Limnoria* increased in large numbers at Liverpool, N.S., Portland, Me., and as far south as New York. They reached a peak in 1940, showing there were 100 times as many borers of both species compared with a few years earlier. While *Limnoria* continued its rapid decrease from 1941 to 1945, *Teredo* almost disappeared in 1943. Thereafter, *Teredo* rose again by 1945 until it reached another peak period from 1951 to 1953, while *Limnoria* increased in number again and reached another peak from 1951 to 1955.

The water of New York harbour has been practically free of borers as indicated in authoritative writings published during the past three decades. Up to 1955, within its inner harbour limits, from Brooklyn Navy Yard, through East River, Astoria, Hunt's Point, North River, turning south down to Newark Bay, S.I., only a trace of *Teredo* and *Limnoria* has been noted. Writers invariably attribute this to the low oxygen content of the water due to sewage pollution. The introduction of sewage treatment on a wide scale in the Metropolitan area of Greater New York may result in sudden admission of marine borers in destructive numbers, as Atlantic Beach and Fire Island on the south shore and Fishers Island at the east end of Long Island are all heavily infested with *Teredo*.

Damage to timber used for wharf construction has been reduced by treatment, by protective measures, or by both; and by the discovery and use of untreated timber which is decay-resistant and resistant to marine borers. The most popular and best known wood with these properties is Greenheart which grows only in British Guiana.

Wood preservation has advanced from ancient primitive treatment to modern technological methods which consist of poisoning the food supply of the fungi, termites, and marine borers in timber by chemical or creosote treatment generally by pressure processes in preference to boiling. Creosote treatment has become the most common. It had its advent in the year 1836 when Franz Moll first proposed its use and took out a patent. It was followed in 1838 by the taking out of another patent by John Bethell who devised the present method of injecting creosote into wood under considerable pressure. However, creosoting did not become commercially important until 1875.

During the past 86 years of wide use of creosoted piles, it has been observed that while piles so treated, when completely buried in the soil, should not decay regardless of the ground-water level, they have shown varied serviceable life, from the neighbourhood of the mud line up, depending upon locality, degree of exposure and attack, species and seasoning, treatment penetration and net absorption.

Despite the availability of creosote treatment, various other protective measures have been tried time and again. They fall under two general classifications : " armoured coating " and " armoured encasement." Earliest examples consist of metal cylinders placed around fir piling in Puget Sound waters in 1882 by the Northern Pacific Railway, and the "Keywest armour process" once used in 1889 in San Francisco Harbour. There have since been developed and patented dozens of methods and processes until the emergence of the "sectional gunite encasements" for repairing piles damaged by decay and marine borers, developed during World War II. Among these processes and methods of painting, coating, armouring and encasing, some has given excellent results over 30 years, but none has been found permanent, or positive, above the mud line.

In the decay and marine-borer range, even with concrete encasement, decay may still enter from the top of the pile, and attack by marine borers may occur above the encasement if this portion is within salt-water spray and below the encasement unless the latter

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penetrates into the mud line. Moreover, rock borers such as *Pholads* have been known to open holes in a 1½-in. concrete encasement, permitting *Teredo* to enter the wood. In Los Angeles Harbour, it was revealed in 1922 that over half of the concrete-jacketed piles were more or less attacked, and one-fifth badly damaged, by *Pholads*.

The concept of securing greater protection by combining creosoting and encasing was twice investigated on a Southern Railway coal pier in Charleston, S.C. The original pine piles driven in 1914-1915, had a 20-lb. creosote treatment and cast-in-place concrete jackets extending from 2-ft. below low water to 1-ft. above high water. *Limnoria* attack was first noticed in 1924. In the spring of 1943, attack by *Bankia gouldi* was noted in the deep-water sections, and by the autumn of the same year 30 per cent of the piles were destroyed below low water. This necessitated reconstruction in 1944, using both creosote treatment and concrete encasement.

An historical account of damage to timber used for wharf construction would not be complete without mentioning the classical efforts so far made in this direction. In the United Kingdom, the Committee of the Institution of Civil Engineers (London) published in 1920 a Report on "Deterioration of Structures in Sea-Water" and Annual Interim Reports through to 1938. In the United States, the Committee on Marine Piling Investigation of the National Research Council published its report in 1924 under the title, "Marine Structures, Their Deterioration and Preservation," by W. G. Atwood and, A. A. Johnson. Covering practically all phases of the marine borer problem, the San Francisco Bay Marine Piling Committee published its Final Report in 1927 under the title, "Marine Borers and Their Relation to Marine Construction on the Pacific Coast," by C. L. Hill and C. A. Kofoid. Various valuable reports of the work of Dr. William F. Clapp on marine research in his Marine Biological Laboratory at Duxbury, Mass., have been issued during the past three decades. They contribute greatly in clarifying the problem of marine-borer attack and in advancing solutions.

CLASSIFICATION OF DAMAGE

For logical convenience in treating the subject, physical, chemical, and biological damage to timber used for wharf construction will be further classified under the headings of:

- (I) Biological damage
  - (a) Marine borer attack
  - (b) Decay—plant life attack
  - (c) Insect attack
- (II) Physical damage
  - (d) Natural damage
  - (e) Physico-chemical damage
  - (f) Meteo- and hydro-physical damage
  - (g) Geophysical damage
  - (h) Mechanical damage
  - (i) Damage to treated timber
  - (j) Fire hazards
  - (k) Damage due to improper design, construction, maintenance, and operation.

Vertical, Latitudinal, and Geographical Distribution

Biological damage to timber used for wharf construction may be first characteristically treated with respect to vertical variance, latitudinal extent, and geographical distribution before examining the mechanisms of attack by plant and animal life. For damage other than biological, such categorical distribution is obvious.

Vertical Variance

Vertically and biologically, timber used for wharf construction confronts four range levels: (1) the range above highest high water, where timber is chiefly damaged by decay; (2) the range between tide levels, where both marine borers and decay cause serious damage; (3) the range from lowest low water to somewhat below the mud line, where timber is predominantly threatened by marine borers, but suffers no decay; (4) the range below the mud line, where timber is almost free from any biological damage.

Decay occurs above low-water level in open piling, and above the ground-water level in buried piling. If the ground-water level is low, at depths of more than 5-ft. below the ground surface, the rate of decay is generally very slow in dense, compact soils, but decay may extend much deeper in light, sandy, or gravelly soils. In interior framing in a wharf superstructure, if air-dry condition is maintained, there would be no decay, as wood-destroying fungi need a moderate amount of moisture for growth. From below fibre-saturation point, decay develops and increases rapidly with more moisture, until its growth is limited by insufficient air. In dry, cold climates, decay in interior piling for wharf construction is usually confined to near the ground line. In the Southern States and the Mississippi Valley, decay may often occur on the sides and tops of piles.

Termites of the "subterranean" type attack the wood by burrowing through the soil, as they must have access to the ground at all times to get the required moisture to sustain life; while the "dry-wood" type flies and is hence active above ground level.

Beetle larvae do not live below water level. They apparently prefer timber that is not far above high water, or periodically subjected to salt spray. They attack piles above the tide level. One of the most important beetle borers is the *European wharf borer* whose larvae have caused considerable damage to bulkheads above high-water line in Novia Scotia, Maine, and Massachusetts, especially on the tops of damp and partly rotted piles. The larvae of some species even attack creosoted timber above high water.

Marine-borer attack generally extends from the mud line to high-water line in salt or brackish waters. Marine-borer infestation may increase or decrease in estuaries and river mouths as salinity increases or decreases respectively during times of low or high fresh-water stages.

Teredo attack usually covers the range between mud line and low-water line, though it is often active in the tidal range, and at some locations heaviest at the mud line. At times of receding waters, when piles are exposed above mud flats, *Teredo* infestation will cease. *Teredo* burrows may extend somewhat below the mud line to quite a few feet above the high-water line, in the latter case the needed water is sucked up by the borer.

Bankia attack may sometimes be concentrated at the mud line. However, at many locations in the tropics, and at some locations in the temperate zone, the attack is just above mean low water.

Limnoria attack occurs at all levels from mud line to high water, though points of maximum attack are often found at mean-tide level and just above the mud line. Occasionally, it may be most active in the tidal range as in the waters of Savannah, Ga. and Charleston, S.C., but usually below low-water line. When piles are exposed above mud flats, *Limnoria* can usually continue to work if the mud is wet. *Chelura* burrows are similar to those of *Limnoria;* it drives *Limnoria* out of the original tunnels and occupies them.

Sphaeroma attack may work at all depths, but principally in the tidal range where large, dark open burrows are produced with pitted appearance and with occasional surface channels, especially in deeper submerged portions of the piles.

Latitudinal Extent

Though decay is widespread in the world, and occurs throughout the United States, its intensity is greatest in the Southern States, because temperatures between 65° and 95°F. provide conditions for optimum growth of fungi, while they cease to grow between 104° and 115°F. and become inactive as temperature approaches freezing.

Both subterranean and dry-wood termites are widely distributed throughout the United States, but the latter are most abundant in southern coastal regions, as they attain their optimum development in tropical and semi-tropical climates.

The severity of attack by destructive marine borers varies greatly in different localities. They are in general most active in warmer seasons, in warm waters, and in the tropics, but they have caused serious damage to timbers in wharves as far as the most southerly, and beyond the most northerly, limits of the respective temperate zones. A dock in Alaskan waters at latitude 60°N was destroyed in one and a half years. Marine borers exist in the water of North Cape in extreme northern Norway, which is situated some five degrees above the Arctic Circle.

Geographical Distribution of Marine Borers

Marine borers have a wide distribution throughout the waters of the world except in the polar regions. Some waters are less favourable to the reproduction of certain species of marine borers in certain cycles of years, but conditions may change and attack by borers may have occurred before it is even noticed.

Without differentiating all the genera and their several hundred different species under *Teredinidae* alone, the following brief account of the geographical distribution of marine borers, according to observations up to 1955 and published records up to 1956, will group, for convenience, the subfamily of "Molluscan" borers into *Teredinidae* (mainly the genera of *Teredo* and *Bankia*) and *Pholadidae* (as including *Pholads* and *Martesia*), and the subfamily of "Crustacean" borers as including the genera of *Limnoria, Chelura,* and *Sphaeroma*.

Teredinidae have been found in salt or brackish waters on the Atlantic from Newfoundland and Nova Scotia, Canada, down to the Gulf of Mexico, in Bermuda and British West Indies, in Guantanamo Bay, Cuba, in the Caribbean Sea, in Venezuela; on the Pacific coast and on the islands of the Pacific, notably the Marianas, Japan, and the Philippines; in Europe from the North Cape of Norway to Italy; and in the Black Sea. *Teredine* borers have also been found in fresh waters in parts of South America, in India, and in Australasia.

Pholadidae are widespread and have been found on the Atlantic and Pacific coasts of North America, on the Gulf of Mexico, in British West Indies, in Guantanamo Bay, Cuba, in the Caribbean Sea, on the Marianas and Philippine islands of the Pacific, and in Australia. As *Pholads* can bore concrete-jacketed, or concrete-encased piles, sometimes they serve as the forerunners of teredine borers which attack the timber piles through the *Pholads* holes.

Limnoria has been found in all salt or brackish waters from cold to warm, from clean to polluted. It exists on the Atlantic coast of North America from Newfoundland and Nova Scotia, Canada, to the Gulf of Mexico, in Bermuda and British West Indies, in Guantanamo Bay, Cuba, in the Caribbean Sea, in Costa Rica and Venezuela; on the Pacific coast and on the islands of the Pacific notably the Marianas, Japan, and the Philippines; in Europe in English waters, up to Arctic Circle, and in the Baltic Sea; in the Black Sea; and in the southern hemisphere from New Zealand, Australia, South Africa, to the Falkland Islands of South America.

Chelura has been found on the Atlantic coast from Labrador, Canada, down to the Florida Peninsula; on Hawaii, Samoa, and other islands of the Pacific; in New Zealand and Australia; in northern Europe; in the Black Sea; and in the Cape of Good Hope, South Africa.

Sphaeroma has been found on the Pacific Coast of North America; more abundantly in tropical waters from Florida to Brazil; and in South Africa, India, Ceylon, New Zealand, and Australia where it is most destructive in Queensland. It exists in brackish to almost fresh water and has made severe attacks in the St. Johns River in Florida.

On the coasts of the United States and its possessions, the intensity of marine-borer attack varies greatly from location to location. From information observed up to 1955 and published up to 1956, a condensed compilation is assembled in Table 1, in which only the two most important genera of marine borers are represented, with P denoting "present" without definite intensity, S standing for "slight," M for "moderate," and H for "heavy."

In particular, heavy attacks by both *Teredinidae* and *Limnoria,* which would cause rapid destruction to unprotected submerged timber, were concurrently taking place in 1955 at the following locations of the United States and its possessions:

Table 1. Intensity of Marine-Borer Attack on the Coasts of the United States and Its Possessions

Coast	Teredinidae	Limnoria	Coast	Teredinidae	Limnoria	Coast	Teredinidae	Limnoria
Maine	S-M	S-M-H	North Carolina	M-H	H	Canal Zone		
New Hampshire	M	M	South Carolina	H	S	Caribbean End	H	H
Massachusetts	S-M-H	S-M-H	Georgia	P	P	Pacific End	H	M
Rhode Island	M-H	S-M-H	Florida	H	H	California	M-H	S-M-H
Connecticut	S-M-H	S-M-H	Alabama	S-H	S	Oregon	P	P
New York*	S-M-H	S-M-H	Mississippi	P	P	Washington	H	S-M-H
New Jersey	S-M-H	S-M	Louisiana	P	P	Alaska	M-H	M-H
Delaware	H	S	Texas	S-H	S-H	Hawaii	H	H
Maryland	S-H	P	Virgin Islands	H	H	Marianas	H	H
Virginia	M-H	S	Puerto Rico	H	H			

*Only a trace in the inner harbour of New York.

Massachusetts
Salem
New Bedford
Woods Hole

Rhode Island
Coddington Cove

Connecticut
Mystic
New London

New York
Fishers Island

North Carolina
Morehead City
Wrightsville Beach
Southport

Florida
Mayport
Daytona Beach
Fort Pierce
Key West
St. Petersburg
Panama City
Pensacola

Texas
Galveston
Port Isabel

Puerto Rico
Fajardo
Playa Ponce

Virgin Islands
Charlotte Amalie

Canal Zone (Caribbean End)
Coco Solo
Fort Sherman

California
San Diego
San Pedro—Terminal Island
Monterey

Washington
Port Angeles
Friday Harbour
Bellingham

Alaska
Kodiak

Hawaii
Pearl Harbour
Midway Island

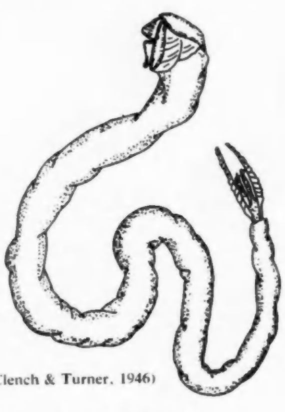
Marianas
Guam

Marine Borer Attack

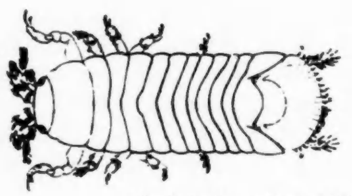
Marine borer is a general term used to represent any of the several hundred species of marine invertebrates which bore into timber and some even into concrete and rock except the hardest aggregates. The two groups of these destructive organisms, (1) Molluscan and (2) Crustacean, have different methods of attack on timber.

Borers of the *Molluscan* group, principally (a) *Teredo*, (b) *Bankia*, (c) *Pholads* and (d) *Martesia*, enter the timber by boring minute holes when young, grow inside them, and destroy the interior of wood at a rapid rate during their growth. As a slimy coating of micro-algae and other unicellular organisms cover the submerged surface of wood, it requires most careful inspection with a hand lens to detect the entrances. But the extent of inside damage can only be revealed by cutting.

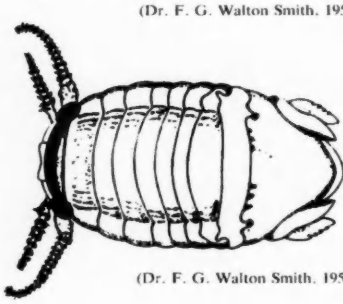
Borers of the *Crustacean* group, chiefly (a) *Limnoria*, (b) *Chelura*, and (c) *Sphaeroma*, destroy the outside surface of the timber, and hence can be readily recognised by surface inspection.



(Clench & Turner, 1946)



(Dr. F. G. Walton Smith, 1957)



(Dr. F. G. Walton Smith, 1957)

Fig. 1 (above). Teredo.

Fig. 2 (top right). Limnoria.

Fig. 3 (bottom right). Sphaeroma.

For centuries the terms "shipworm" and "pileworm" have been applied to various marine borers, especially Teredo, and the terms "gribbles" and "putty bugs" to Limnoria. Molluscan borers are bivalves like oysters and clams, while Crustacean borers are related to crabs and lobsters.

It is important to note in passing that many of the fouling organisms seem to require about the same conditions as the destructive borers, and that their presence at a certain location is indicative of the fact that there is liability to marine-borer infestation even if it is free at the time of construction. Besides the possibility of importing marine borers by infested shipping or driftwood, and the creation of favourable conditions for such borers by changes in their food supply and natural environment, other more important factors that have significant bearings on the presence and activity of marine borers include salinity, pollution, temperature and breeding seasons. However, the chief concern of this section of the paper will be directed only to the borers themselves and their mechanisms of attack.

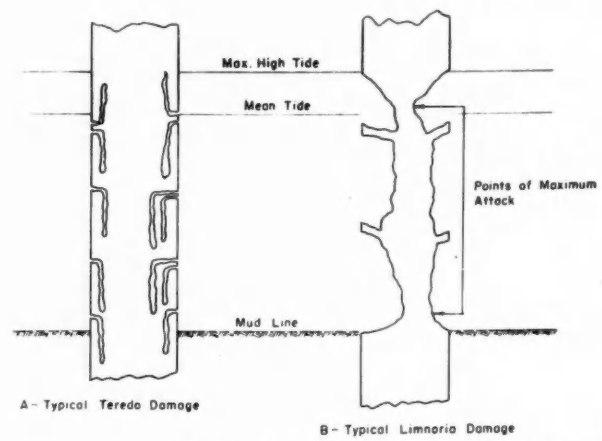
(1) Molluscan Borers and Their Attack:

(a) *Teredo* has a head with two valves of the shell used for boring, a greyish and slimy wormlike body, and two unequal siphons like a forked tail projecting from the burrow. Near the siphons is a pair of plumose or paddle-shaped pallets which serve as plugs to close the entrance of the burrow against anything which is undesirable. The size of the mature individual of the common species ranges from about ⅜-in. to 1-in. in diameter, and from 5-in. to 6-ft. in length. Individuals have been discovered in Pacific islands in sizes more than 3-in. in diameter and from 3½ to several feet long. In areas of heavy attack, the strength of an untreated pile may be totally destroyed in as short a period as half a year.

Teredo starts its life of boring wood in the larval stage in 36 hours within which time, if the larvae have not yet found a suitable domicile, they become adults, will not be able to enter the wood, and will die. *Teredo navalis* enters vertical piles in tiny horizontal adit holes starting in diameter as small as 0·008-in. and reaching 0·03-in. later. These short adit holes turn down to vertical burrows which expand afterwards to their full diameter. The burrows are lined with a thin wall of nacre which scales off easily. They may turn or twist to avoid inter-crossings, or the borer may partly withdraw and commence a new burrow. There are no cross ridges in the burrows.

(b) *Bankia* is similar to, but usually larger than, *Teredo*, may grow in size to 1-in. in diameter and 3 or 4-ft. long, and has a pair of long plumose pallets projecting behind the siphons. *Bankia setacea* burrows enter vertical piles in horizontal pinhole size, usually turn down obliquely even beyond the sapwood before again turning to run with the grain. The burrows generally enlarge to ½-in. diameter within 4-in. from the wood surface, but larger sizes of ⅞-in. diameter and more than 2½-ft. long have been found in San Francisco Bay. In light infestations, the nacreous-lined burrows penetrate deeper than those of *Teredo*, and in heavy attack, all burrows run toward the centre. *Bankia setacea* can bore faster, and make larger burrows farther apart, than *Teredo*, so that, in light attack, the wood may not be fully destroyed. But in heavy infections, the damage may be as serious as that of the worst *Teredo*.

(c) *Pholads* (*Pholadidae*) are enclosed in their clamlike stout, roughened shells, and use them for boring. They drill their small entrance holes, when young, into wood, mortar, concrete, rock, and mud by opening and closing their shells and so producing a rapid abrading action. They can make cavities up to 1½-in. deep in the hardest woods, and they are stopped only by the hardest aggregates. Their burrows increase in size with depth and growth, and are not lined. Their entrance holes, though somewhat larger than those



(Beach Erosion Board, OCE, U.S. Army Corps of Engineers, 1955)

Fig. 4. Typical pile damage by Teredo and Limnoria.

made by *Teredo*, are still minute and hard to discern by surface inspection. Their population is widespread in the world but fewer in number than *Teredo*. Hence, they cause comparatively less damage, though it is more difficult to prevent their attack.

(d) *Martesia* has its body entirely enclosed within the shells like a clam, and grows to 1-in. in diameter and 2-in. in length. *Martesia Striata* shows a straight seam, bores tiny round entrances that rapidly develop good-sized circular holes inside the pile, reaching usually in a year to about the length of the borer, limited apparently by the desire to keep its siphon ends in the entrance. It may cause rapid wood disintegration in a heavy attack, and has reduced the pile diameter by ¼-ft. in only one year.

(2) **Crustacean Borers and Their Attack:**

(a) *Limnoria lignorum*, the most widely distributed of Crustacean borers, a common gribble or sea louse resembling the wood louse in appearance, sometimes known as the "surface worm" in spite of its being slipper-shaped, has a body varying from $\frac{1}{8}$-in. to $\frac{1}{4}$-in. in length and $\frac{1}{3}$-in. to $\frac{1}{2}$-in. as broad, and two sets of antennae. Its mouth contains a pair of strong, horny-tipped mandibles with which the boring is done. Its body has seven pairs of legs ending in sharp, hooked claws so that it can move freely and cling to timber. It can crawl, jump, roll itself up into a ball, and uses its gill plates for swimming.

Limnoria destroys timber by following the softer rings and by gnawing interlacing shallow branching burrows on the surface from a depth of 0·025-in. to a depth seldom over $\frac{3}{4}$-in., thus leaving, within $\frac{3}{4}$-in. from the surface, a mass of thin walls between burrows that breaks away and exposes a new surface to attack. In heavy attack, there have been counted as many as 400 individuals of *Limnoria* per sq. in. They avoid hard knots and can burrow into soft timber piles of pine and spruce to a depth of 1-in. a year, reducing the pile diameter 2-in. a year, resulting in a narrow-waisted effect on the pile until it breaks.

(b) *Chelura* is somewhat larger than, and present in the same localities as, *Limnoria*, but is distinguished from *Limnoria* by its pinkish tinge, and by turning to red in the sun after half an hour. Its antennae, legs, and joints in the body are heavily feathered with long hairs. Terminal segments of the last pair of abdominal legs of male *Chelura* consist of two smooth, stout club-shaped structures, nearly half as long as the body, used to block the burrow. *Chelura* swims, jumps, and, when present in large numbers, seems to drive out and occupy the burrows of *Limnoria*, thus indicating its destructiveness is less than its inhabitation.

(c) *Sphaeroma* species resemble *Limnoria* in appearance, but are generally more oval and larger, up to $\frac{1}{2}$-in. long and half as broad. They are sometimes known as "pill bugs" by virtue of their habit of rolling up into a ball, about $\frac{1}{4}$-in. in diameter, when disturbed. *Sphaeroma pentodon* bores round openings of separated location, up to $\frac{1}{2}$-in. diameter. The adits enter piles horizontally, then turn quite abruptly, and run with the grain in the softer layers of annual rings without expansion of the burrows as characterized in Molluscan burrows. They produce a pitted appearance of piles between tide levels, revealing large, dark open burrows, with occasional channels in the surface, especially in deeper submerged portions of piles.

(to be continued)

Correspondence

Why Not Abolish Tallying?

To the Editor of the Dock & Harbour Authority.

Sir,

The correspondence in your June issue in the context of Poseidon's earlier article is highly diverting though it would seem that in most instances the authors have been so entranced by the title that they have not bothered overmuch with the smaller print. Of course a tally must be kept at those points where the custody of goods changes. Poseidon's thesis is concerned primarily with the ship's tally of cargo being discharged and he is at pains to show that where custody changes at the ship's side the value of the tally is almost nugatory. He might have added that the subsequent tallying operations place the affording agent at an immense tactical disadvantage. Here we see gamesmanship of a high order.

The tally by the ship need be no more than a copy, more or less plausible, of the manifest— as it often is. When interrupted at any point the last entry will not necessarily be the cargo which has just come off the hook. It will not as a rule pick up overcarried or short landed cargo for this will not appear on the manifest for the port in question. The affording agent's inward tally of the same cargo will generallly show a shortage for to carry out a bona fide tally in those conditions calls for almost superhuman qualities of eyesight, patience and concentration. Inevitably there will be lacunae. The real trouble however, begins when the delivery tally is made, in circumstances which usually can ensure its accuracy, and it shows a quantity greater than that ostensibly received but still less than the ship's tally. The affording agent then has the onus of proving the non-existence of the missing cargo. Both its tallies are suspect for their inconsistencies will not hold up well against a single tally made up all of a piece. Much picturesque discussion then ensues for the conflicting records can at least be relied upon to lend an air of verisimilitude to what otherwise might be a somewhat bald and unconvincing tale. Ultimately, of course, except in a small minority of cases, the missing cargo turns up, possibly, overstowed in a shed or having inadvertently been put off at some other through port, and the ship's tally (or, should we say the manifest?) is proved correct.

And this should occasion no surprise, if indeed it is a true record of the cargo loaded—a result achieved by the simple expedient of accepting a Shipping Note more or less at its face value and adjusting the rate of loading so that an adequate physical check of its contents can be made. Thereafter, on discharge, the transfer can be made without reference to marks and without noticeable solicitude for the comfort and convenience of others. The spectacle put about is that of a near-perfect manifest and everything pertaining to the work of the carrier, and of a bumbling incompetence on the part of all others associated with the transfer operation.

But here is a game which two can play at—and make a much better showing; a simple tactical withdrawal will require the carrier to continue his contract to a point where the consignee can reasonably be expected to take delivery. The carrier will then be careful to stow his cargo according to marks and to discharge it according to marks and will not lightly accept goods for shipment when presented in a manner which might hamper those processes. Of course, much of the tomfoolery which now enlivens the industry would be knocked on the head but it is just conceivable that commerce and the public at large might prefer it that way.

Yours very truly,
P.A.T.C.

Maresfield, Sussex.
30th June.

To the Editor of "The Dock and Harbour Authority."

Sir,

I thought I was getting too old a trout publicly to rise to such an obvious fly as Poseidon's article! On reading the ensuing correspondence in your June issue, however, I would like to express my feelings on tallying which provided a subject for acrimonious discussion in the shipping industry long before my entry into this world; and will probably continue to do so long after I'm dead and forgotten.

1. Cargo must be considered as valuable. It is therefore reasonable and common practice that the owners or bailees of cargo should expect the cargo to be checked and signed for when it passes from one custodian to another.

2. A shipowner by his Bills of Lading limits his responsibility (roughly speaking) to the time during which the cargo is on board his ship.

Correspondence—continued

3. This leaves a vacuum whilst the cargo is lying in the port, i.e. in the case of export cargo between delivery by land vehicles at the quay and the loading into the ship; and the reverse in the case of import cargoes.

4. Tallying is always suspect because of the human element involved. It should therefore be undertaken at the place and time where counting is simplest and error least likely to occur.

5. Experience (so far as I am concerned) shows this to be when the land vehicle is loaded or discharged at the quay. The man in charge of the vehicle who has to give or receive a receipt is an additional check on the tallyman.

6. How much simpler would it be if the cargo were received ex land transport by the shipowner (or an agent responsible to him) and after being conveyed by sea were once again dealt with by him or his agent until delivered to land transport.

I believe the foregoing to be the true and simple solution to the tallying problem. I have no particular faith in a ship's hold or ship's side tally. I know of one classic case in which high duty dried fruit was landed at one port and subsequently conveyed by barge to another port where it was taken to a bonded warehouse and ultimately delivered to the owner. In all, nine separate tallies (including Custom's) were taken and none of them agreed with any of the others.

Of course, the suggested solution is unlikely to take place for decades to come; there are far too many interests involved. But it's very bad logic to argue that because tally clerks are awkward tallying should be abolished. The proper solution is to stop them from being awkward.

Yours faithfully,

23rd June, 1961. VIA MEDIA.

Loss Prevention for Cargo

In the May 1961 issue of this Journal we printed an article entitled "Why not abolish tallying?" by Poseidon, whose views have proved controversial. Correspondence on the subject was reproduced in our June publication and is continued in the current issue but not all of those who believe that it is essential that goods should be tallied every time they change custody have mentioned the question of condition, which arises simultaneously. An exporter is not only keen that his customer shall receive the correct number of packages; he is also concerned that the consignment shall reach its destination in good condition. Methods of preventing cargo losses, whether due to theft, poor handling, unsuitable stowage, fresh or sea water damage or any other cause, are always being discussed and sought and one of the duties of the cargo superintendent's tally clerk is to draw attention immediately to any damage or deterioration in the consignment he is tallying, so that investigation into the cause may be made without delay.

As mentioned in the editorial column of our May 1961 issue, the marine service department of the Insurance Company of North America has prepared a report on loss prevention for cargo in foreign trade. The first part of the publication takes a cross-section of world ports, which are briefly reported on, from an insurance company's point of view, under five headings: discharge facilities; labour and handling; delay and congestion; pilferage and damage; and climate. The second part deals with recommendations for loss prevention and there are sections on the types of packaging which should be employed to obtain the best results in shipping cargoes.

In a table, based on the Company's experience, losses occurring during each five-year period since 1946 are compared and it is interesting to see that, whereas those due to theft and pilferage have been progressively reduced, those due to handling and stowage have been consistently increased. Both types of losses are, of course, particularly affected by two factors: the quality of supervision and the packing methods employed and it would therefore be interesting to know what cargo handling experts think is the reason why, whereas the proportion of theft and pilferage damages has decreased from 29% (1946-50) to 24% (1951-56) to 21% (1956-60), losses attributable to handling and stowage rose, in the same respective periods, from 27% to 34% to 41%

Even a breakdown of the handling and stowage losses, as shown in the following table, throws little light on the problem.

	% of all losses		
Handling and Stowage	5 years (1946-50)	5 years (1951-55)	5 years (1955-59)
Breakage	15%	16%	19%
Leakage	2%	2%	2%
Contact Other Cargo	2%	2%	1%
Oil Damage	1%	—	1%
Hook Damage	1%	1%	1%
Contamination	2%	5%	7%
Slackage and Short Weight ...	4%	8%	10%
Total as % of all losses ...	27%	34%	41%

The Company, however, considers that the continued increase in losses under this heading indicates that packing protection has been reduced faster than handling methods have been improved. It further regards this as the tendency of many short-sighted shippers to sacrifice proper protection so as to lower costs.

We have mentioned more than once recently in this Journal that instances of inadequate packaging are matters which discharging and loading agents should bring to the notice of the appropriate interests. The shipper is often in a quandary in this sphere, for he may find that, although his standard packing may stand up well to the handling and transporting conditions in one route, it is inadequate in another. Those responsible for moving his consignments are in the best position to advise him.

Publication Received

Handbuch für Hafenbau und Umschlagstechnik (Handbook of Dock and Harbour Engineering and Cargo Handling Technique), Vol. V, 243 pp., size 8½-in. x 11¾-in., numerous illustrations. Published by Schiffahrts-Verlag "Hansa" C. Schroedter and Co., Hamburg, 1960.

The present volume, the fifth in this series, which has been published under the auspices of the Hafenbautechnische Gesellschaft (Association for Dock and Harbour Engineering), contains reprints of the articles on dock and harbour engineering and cargo handling which appeared in the well-known German journal "Hansa" during 1959.

To anyone acquainted with that journal and the consistently high standard of the articles published in it, the book under review—which could, in fact, be described as the "1959 Annual" of the Port Engineering section of "Hansa"—will hardly call for recommendation. It contains a wealth of information on a wide range of matters within the general scope of its subject. The articles are grouped under various headings: Maritime waterways; Sea ports (general aspects); Descriptions of specific ports and their installations; Maritime engineering works, design and construction methods, etc.; Inland waterways; Inland ports; Cargo handling technique. A convenient index and a table of contents facilitate reference to any particular article.

Some Notes on the Electrical Requirements of General Cargo Docks

By E. R. RADWAY, C.G.I.A., M.I.Mech.E., M.I.E.E., M.I.Struct.E.
Mechanical and Electrical Engineer, South Wales Docks
(British Transport Commission)

(Continued from page 48)

Balanced-Jib Level-Luffing Cargo and Grabbing Cranes

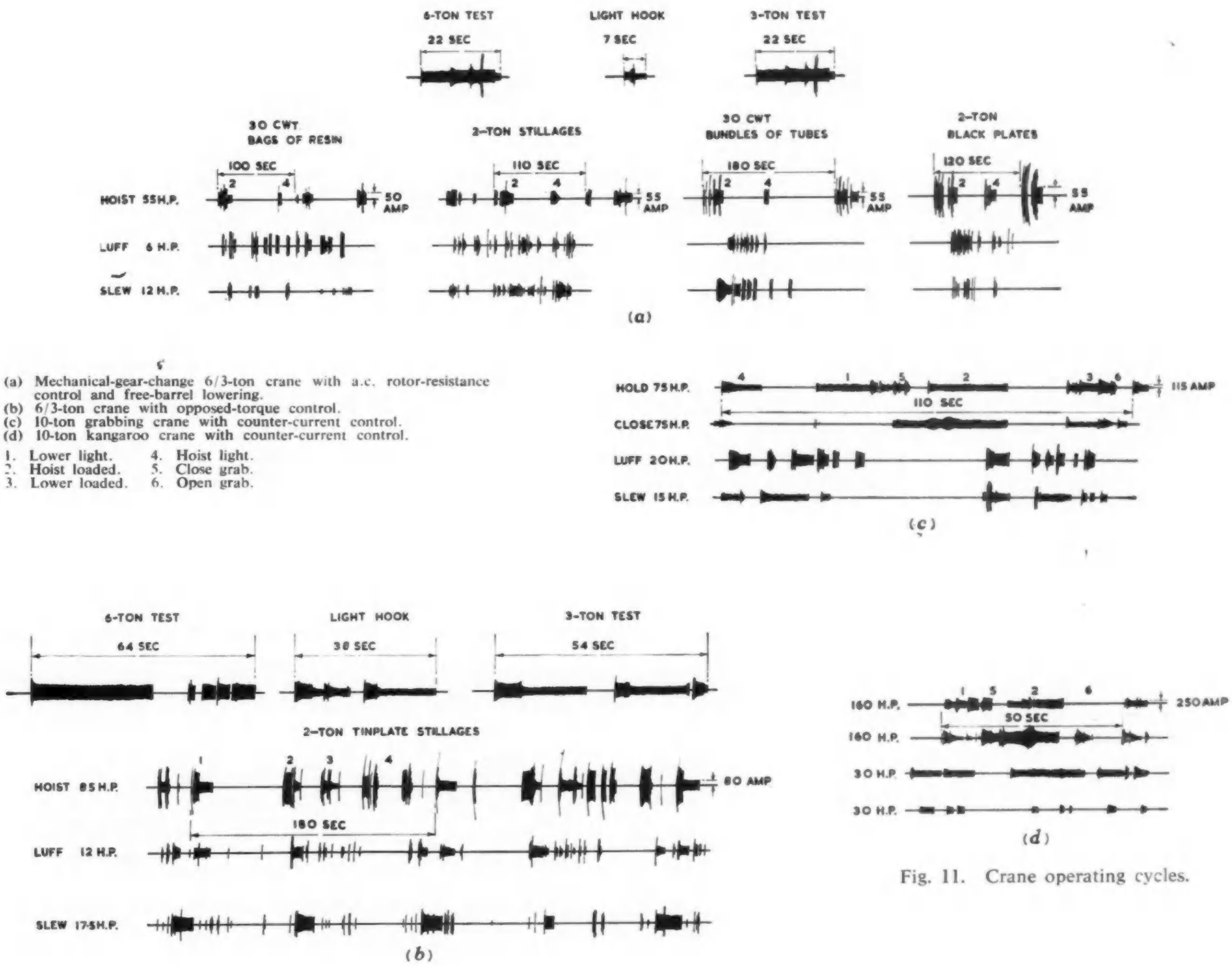
Electrically operated balanced-jib level-luffing cranes of relatively small radius and low pedestal structure, with hoisting speeds of 200 ft/min for 3-ton loads and 100 ft/min for 6-ton loads, have been the accepted practice for general cargo handling, using approximately four 3-ton cranes to one 6/3-ton crane per berth, the latter having a 2 : 1 mechanical change gear. The increasing size of general cargo vessel, the demands for a quicker turn-round and the trend for a greater proportion of cargo packages to exceed 3 tons are leading to the specification of 65/80-ft. radius 6/3-ton cranes, or possibly higher capacity where grabbing work predominates, on high pedestals, with hoisting speeds ranging between 150 and 300 ft/min and the mechanical speed-change gear replaced by automatic electrical methods. Maximum slewing and luffing speeds of 600 ft/min at maximum radius and 200 ft/min, respectively, remain approximately the same as the earlier designs.

Recordings of normal crane operating cycles for various types and capacities of crane are given in Fig. 11, which, if considered in conjunction with Fig. 7 (shown on page 46 in the June issue) and a specified number of cycles per hour, can give a reasonably accurate assessment of requirements.

Crane Control

The characteristics of the d.c. motor are excellent, but to obtain the advantages of a.c. distribution, cranes driven by slip-ring induction motors—notwithstanding the difficult speed control—are in general use. Depending upon the crane size and duty,

*Paper presented at the Institution of Electrical Engineers, London, in February 1961, and reproduced by kind permission.



(a) Mechanical-gear-change 6/3-ton crane with a.c. rotor-resistance control and free-barrel lowering.
(b) 6/3-ton crane with opposed-torque control.
(c) 10-ton grabbing crane with counter-current control.
(d) 10-ton kangaroo crane with counter-current control.

1. Lower light. 4. Hoist light.
2. Hoist loaded. 5. Close grab.
3. Lower loaded. 6. Open grab.

Fig. 11. Crane operating cycles.

drum resistance controllers of the full-load or the master-controller type operating in conjunction with contactors are suitable for slewing and luffing. For travelling, the full-load drum controller is adequate, but direct-on-line-starting squirrel-cage machines driving through fluid couplings has been recently applied.

The full-load drum controller, giving rotor-resistance speed control, together with a mechanical gear change on dual-purpose hoist motions, has given good service, but the higher speeds, greater size and increased mechanical efficiency of to-day necessitate electrical and physical improvement of control. The larger currents handled demand master-controller and contactor gear, and the higher speeds and size require improved braking, suitable low speeds to avoid snatch when tightening cargo slings, and the replacement of mechanical speed-changing gear by efficient electrical methods.

Various control schemes are compared in Table 3 and some speed/torque characteristics given in Fig. 12.

Future Crane-Control Development

The complicated methods developed to provide accurate speed control of a.c. slip-ring machines necessitates a recasting of line of thought with a view to simplification. Resistance control of a.c. motors for slew and luff motions probably will be retained and it is upon the hoisting motion that research must be concentrated.

The rapid development of semiconductor rectifiers directs attention to the d.c. motor with voltage divider control, supplied by a semiconductor rectifier, and the a.c. slip-ring motor with speed control effected by two semiconductor rectifiers, one arranged as a controlled inverter feeding the slip energy back into the supply.

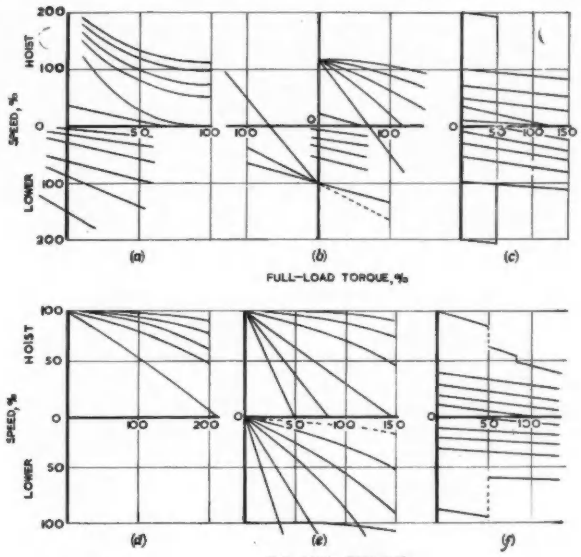
Crane Motors

Dockside crane motors normally are supplied to the British Standard for drip-proof-enclosure 1-hour-rated slip-ring class A insulated machines, with a thermometer-method temperature rise

TABLE 3. Comparison of Crane Control Schemes

	Method	Relative cost	Principle	Advantages	Disadvantages	Remarks
		%				
1.	Slip-ring motor with external resistance control	100 (=£900)	Variation of torque and speed by external resistance in rotor circuit	Minimum first cost	Steep torque/speed curves give rough operating conditions Speed control limited to below synchronism for hoisting and above synchronism for lowering	Low-speed small-radius cranes
2.	D.C. injection braking	158	Hoisting as for (1) Braking obtained by injecting direct current into stator	Controlled lowering of loads	Steep hoisting torque/speed curves A wide range of low-torque operating speeds is not easily obtainable Does not provide for power lowering of light hook at predetermined low speeds	Operating conditions not satisfactory for high-speed general-cargo cranes
3.	Electro-mechanical	200	Low speeds obtained by partial application of an electro-mechanical brake automatically controlled by speed of motor		Speed controlled by mechanical dissipation of heat, giving high brake maintenance	Not suited to heavy-duty high-speed cargo cranes
4.	Counter-current braking	148	Control of lowering by having motor polarity as for hoisting with external resistance in circuit	Controlled lowering of loads with reduction in mechanical brake wear	Steep hoisting speed/torque curves giving rough operating conditions Hoisting speed control possible only with load speed below synchronism Does not provide for power lowering of light hook at predetermined low speeds	In this simple form is not suitable for dockside cranes
5.	Counter-current braking and relay control of rotor resistance	170	As (4) but with rotor resistance controlled by 'fluttering' relays	Flat torque/speed throughout lowering with 20% or more load. Single slow-speed hoist up to 60% load in addition to slip-ring-motor characteristics	As (4), but improved control	Suitable for grabbing cranes, where crane is always loaded with grab
6.	Counter - current - plus - relay control of rotor resistance plus pony motor	217	As (5), but using additional motor at 10–20% of hoist motor b.h.p.	As (5), with extension of the lowering characteristics over complete load ange	As (5), but additional maintenance of motor and control	Suitable for high-speed cargo cranes if space permits
7.	Counter - current - plus - relay control of rotor resistance plus two hoist motors	217	As (4), but using two motors, one of 75% normal hoist motor b.h.p.	Controlled lowering: mechanical change-speed gear not required: hoists light loads automatically at double rated speed	Steep hoisting speed/torque curve: additional rotating machine and space limitations	Advantageous for dual-speed cargo cranes where a considerable proportion of loads are below 25%
8.	Opposed torque using braking unit directly coupled to driving motor	312	Squirrel-cage-motor electric braking unit with field energized by a variable d.c. supply direct coupled to the hoist motor giving opposed torques	Smooth control from 10% to synchronous speed in both directions	Overall length can be difficult	Possible use on high-speed general-cargo cranes if space limitations permit: pole changing could be incorporated in this system to give high half-load speeds
9.	Opposed torque using two electrically separate windings in the same motor frame, forming braking and motoring units	432	By varying resistance of the motor system and the resistance and/or d.c. excitation of the brake system, the combination of opposing torques give different torque/speed characteristics for each system, providing stable no-load speeds where they cross	Stable speeds from standstill to full speed at all loads in both directions: electric braking to standstill: emergency footbrake unnecessary: twice full-load speed provided automatically for loads up to half full-load by pole changing	Heavy current peaks, low power factor and high electrical losses in the opposed-torque steps: motor requires forced ventilation: complicated contactor equipment	Suitable for high-speed general-cargo cranes where average lift is half-load or higher
10.	A.C. commutator motor	487	Speed control by moving of brushes	Smooth control from 10% to full speed	Commutator and brush-ring maintenance high: high rotor inertia: difficult for local repairs	Has proved very successful for fitting-out berths where duty is not arduous. Not favoured for general-cargo duty cycles
11.	Ward Leonard	305	A.C. motor driving d.c. generator	Excellent smooth control with small current peaks: high-speed light hook, with speeds automatically adjusting to load being lifted: no complication in contactor maintenance	Three machines, two with commutators to maintain.	Very suitable for high-speed crane operations

not exceeding 55°C. The crane builder, often working with severe limitations on tail radius and machinery-house width, selects a short large diameter motor, and the motor manufacturer, in order to make a better ventilated motor at minimum cost, offers such high inertia machines without considering the effect on crane performance. When loads moving at high speed become caught in the vessel or cargo, the hoist mechanism inertia, of which the motor rotor provides a high proportion, puts severe stresses into the crane structure. Records indicate several jib failures on the relatively slow older type of crane which must be attributed to this cause, and the increasing speeds of present practice places greater emphasis on this point. Temperature records taken under normal operating conditions show temperature rises well within British Standard limits (Table 4), and this, together with recordings of operating conditions (Fig. 11), suggests that a more factual approach to the design of an adequately rated low inertia motor for dockside crane duty is desirable.



Control
(a) D.C. potentiometer.
(b) Counter current.
(c) Opposed torque.
(d) A.C. rotor resistance.
(e) Rotor control with d.c. injection braking.
(f) Ward Leonard.

Fig. 12. Crane hoist-motion characteristics.

TABLE 4
Hoist Motor Temperature Records
(Approximately 30 cycles per hour for 7-hour period)

Crane	Ambient temperature	Maximum stator temperature by thermometer	Cargo
	degC	degC	
1	14·5	20	General
2	14·5	21	Phosphate
3	12	22·5	Iron ore
4	28	34·5	General
5	15·5	30·5	General
6	20	38	General
7	27	30·5	General

B.S. Class-A insulation; permitted temperature rise, 55°C.

Crane Faults and Failures

An analysis of a year's fault records of 34 cranes of 3 and 6 tons capacity handling general cargo, together with six 4-line 10-ton grabbing cranes and five 10-ton kangeroo cranes engaged on grabbing iron ore, is given in Table 5, classified according to the type of crane and delay times given per 1,000 tons of cargo handled per crane.

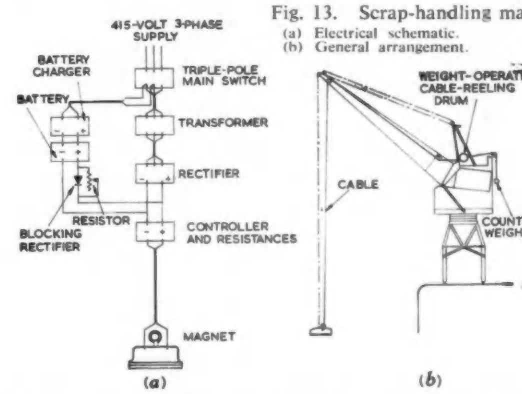
Application of Electric Magnets to Cargo Cranes Handling Ferrous Scrap

Unless the level-luffing balanced-jib single-rope crane is specially arranged during the design stage, ring discharge grabs cannot be used, thus precluding the efficient grabbing of scrap iron. While not comparable in output to a grabbing crane, the fitting of electromagnets to general cargo cranes can provide useful "spillover" berths for handling such cargoes. The electromagnets supplied to cargo cranes follow industrial practice, but some adaptations are required to meet dockside conditions. The range of lift may be 70-ft. or more, making it difficult to use a spring-loaded cable drum for automatic winding of the flexible cable feeding the magnet. A sliding balance weight, with a reversed pulley block system, has proved satisfactory (Fig. 13).

TABLE 5
Crane-Fault Analysis for 12 Month Period

Electrical faults	34 cargo cranes, 3 and 6 tons capacity	Six grabbing cranes, 10 tons capacity	Five kangaroo cranes, 10 tons capacity
	Delay per crane	Delay per crane	Delay per crane
	min	min	min
Ground plugs	6·77	12·1	—
Trailing cables	9·27	12·91	—
Trips and relays	15·96	39·5	26
Controllers	2·82	5·25	6
Wiring	5·43	4·66	36
Clutch or thrustors	10·81	9·09	—
Control panels	4·56	11·67	63
Supply failure	14·18	20·01	72
Motor faults	2·03	3·34	26
Brakes	1·82	3·0	8
Limit switches	—	—	41
Overhead collectors	—	—	72
Miscellaneous	9·40	18·0	—
Electrical delays	83·05	139·53	350
Mechanical delays	31·1	410·2	Not known
Total tonnage handled	710 445	783 136	759 365
Electrical delay per 1 000 tons	3·98	1·07	2·32
Mechanical delay per 1 000 tons	1·5	3·15	Not known

Fig. 13. Scrap-handling magnets.
(a) Electrical schematic.
(b) General arrangement.



Damage to the flexible magnet cable, allowing one magnet to drop the load, is an acceptable risk, but a supply failure causing five or more cranes working together on a vessel to drop their loads simultaneously cannot be countenanced. The solution is to feed each magnet from a battery floating across the supply, suitably trickle-charged by a metal rectifier, normal magnet

operating current being supplied direct by a rectifier of greater capacity. Battery size should be sufficient to sustain the magnet load for about 15 min, giving time for the magnets to be lowered to the ground or the supply to be restored.

Mobile Cargo Handling Plant

Mobile equipment for cargo handling must be robust enough to withstand abusive driving or overloading, and must be able to work over quayside surfaces interlaced with rail tracks, and upon dunnage in the holds. Specially designed equipment has been suggested, but the extra capital cost is difficult to justify, and standard industrial designs are accepted.

Stillage Platform Trucks

Battery-operated fixed and stillage-type platform trucks with 4-wheel steering are in general use. Troubles experienced are chiefly of a mechanical nature, e.g. worn track rods, tyres, damage due to collisions, etc. Apart from normal maintenance of controller contacts, motor brush-gear replacements and occasional commutator pitting by brush jump when passing too quickly over railway tracks, electrical troubles have been few. Batteries must be boxed and wedged to withstand vibration, and arranged for easy replacement. The guaranteed life of lead-acid batteries has been increased to four years by improved manufacturing techniques, but regular inspection and maintenance enables lives of 6-8 years to be attained. For 2-ton trucks, battery capacities of 160-350 Ah at 5-hour discharge rates and 14 and 20 cells are usual. While standard truck designs may not be possible, standardisation of motor dimensions and voltages should be advantageous.

Fork-Lift Trucks

Battery-operated fork-lift trucks of 4,500—10,000 lb. capacities are essential for modern cargo-handling practice, and in general are robust machines. Early designs were without interlocks for preventing movement when the driver's seat was unoccupied and for controller movement from full ahead to full astern, the latter giving the mechanical troubles of broken half-shafts. Battery capacities were also too small, but such faults have now been corrected by most makers. Maintenance accessibility is a difficult problem. Hinged contactor panels and motor mountings and similar improvements are assisting, but there remain such examples as the truck which requires the whole of its front to be stripped for access to the motor brush-gear, and the contactor panel so arranged that a loose connection necessitates complete removal of the panel. Such features must be eliminated.

Battery capacities range from 250 Ah for 4,500 lb. trucks to 960 Ah for 10,000 lb. trucks, with batteries of 18, 24 and 32 cells; the final remarks of Section 5.3.1 apply.

Battery Charging Equipment

With increasing use of mobile plant, the individual charging unit, giving automatically the charge required by the battery's condition, is superseding the method of charging banks of batteries by motor-generator set. This is correct development, but decay of the selenium-rectifier capacity has been experienced.

Mobile Cranes and Sack Pilers

Diesel-electric mobile cranes are in general use, and are reliable machines with few electrical troubles. Early types had 15 min-rated travelling motors, and these were troublesome until replaced by 30 min-rated machines. Even to-day, motor design on some cranes shows weakness.

The sack-piler conveyor calls for little comment electrically. Since it is a portable appliance, with trailing cables subject to damage, its earthing arrangements should be carefully treated, preferably by fitting an earth-proving device.

LIGHTING REQUIREMENTS

Dock lighting requirements are embodied in the Docks Regulations, i.e. "They shall be adequate to prevent danger." The Factory Acts demand a minimum of 6-ft. candles for working areas, and 0·5-ft. candle for walking ways, and until values are defined in the Dock Regulations, the requirements of the Factory Acts are a useful guide. One thing is certain—the lighting conditions considered suitable a few years ago are not acceptable to-day. Tungsten-filament lamps were used for many years, mercury- and sodium-vapour units being considered sources of inteference with signal lights, but this prejudice is being overcome.

Fairway Buoys, Entrance Pier, Lead-in and Signal Lights

While negotiating the dredged channel, which is indicated by buoys, ships are guided by dock signal, "lead-in" and pier lights. Each harbour has its own pattern of coloured lights, with a fixed or flashing characteristic and a visibility range of 4-8 miles in clear weather. If situated in inaccessible places, they should be

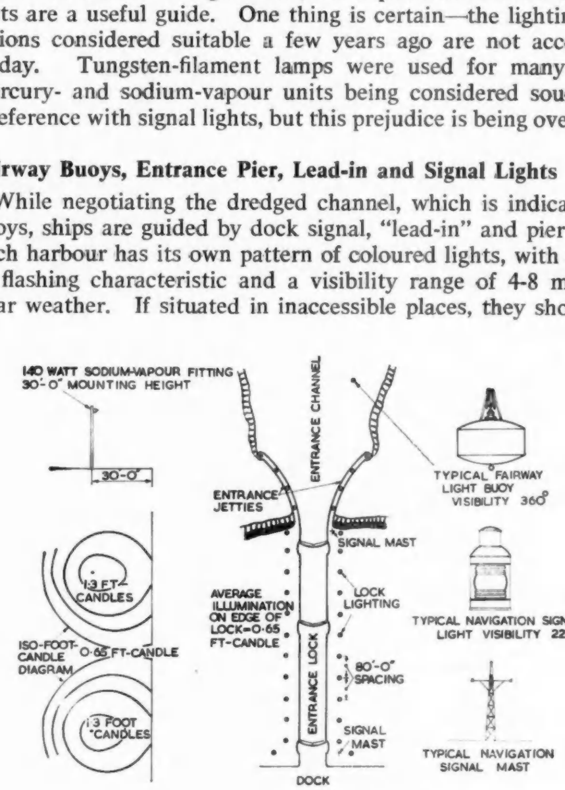


Fig. 14. Dock-entrance lighting.

provided with duplicate lights or lamp changing apparatus, failure of the lamp in circuit automatically bringing a sound lamp into focus.

Control is often effected by a selenium sell operating on the failing light, the flashing signal where required being effected by a timer with suitable cam switching the light on and off, or alternatively by inserting resistance to dim the light.

The increasing intensity of town lighting demands that the designers of the lamp optical systems are fully informed of such background lighting, otherwise disappointment in signal light performance is inevitable.

Lock Entrance Lighting

Once the ship has negotiated the approach channel with the aid of lead-in lights, it must be brought into the lock in all types of weather. Tungsten-filament lighting, often of low intensities, has been the general solution, but sodium-vapour lamps in flood-lighting fittings are becoming increasingly accepted; the lack of glare, clarity of silhouette and clear definition of the lock edge are favourably commented upon, illumination values varying between 0·5 and 1·0-ft. candle being suitable. Fig. 14 gives the data relating to one of several installations which are giving excellent service.

Where aesthetic reasons and not capital costs prevail, street lighting type standards with underground cable supply are used, but often an acceptable minimum cost solution is the wood-pole-and-tier type of overhead-line construction.

Transit Shed Lighting

In transit sheds used for general cargo reception, label inspection for sorting to marks and intensive use of mobile mechanical handling plant is necessary. Tungsten-filament lighting giving an average illumination of 1-3-ft. candles exists in many sheds, but most modern working requirements need the average 6-ft. candles of a factory installation.

The capital cost of mercury-vapour lamps is justified where the annual operating time exceeds 1,000 hours, but for many years colour distortion was thought to preclude their use. This has been exaggerated, and several installations are operating without complaint; but mixed tungsten-filament and mercury-vapour lighting, or the recently developed fluorescent-coated mercury-vapour lamps, would seem the best solution.

Ceiling mounted fluorescent fittings can be used advantageously in sheds with exceptionally low roofs. Where lighting fittings can be supported out of reach of the mobile cranes, a satisfactory economic installation can be made by straining hard-drawn p.v.c.-insulated wires throughout the length of the shed, supported by porcelain insulators on the roof trusses, but the solid drawn conduit system seems more generally acceptable.

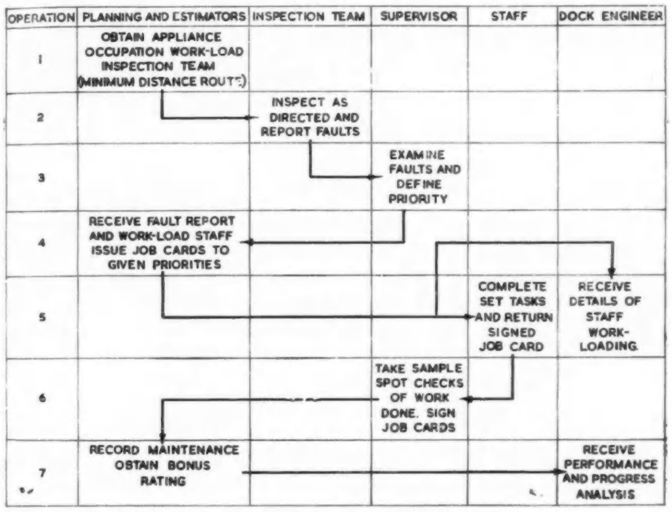


Fig. 15. Planned-maintenance organisation.

Road Lighting

Dock estates have many miles of private roads illuminated by fittings mounted at 15-18-ft., spaced at 120-150-ft., with an illuminated value of average class B standard, only the occasional major road necessitating class A treatment. Directional fittings are in general use, although giving glare, but the advantages of sodium-vapour street lighting fittings are recognised and these are being increasingly applied.

Tier-type overhead-line construction on wood poles is satisfactory for uncongested areas, street lighting standards with cables being used for difficult sites or aesthetic reasons. If the fittings can be supported on buildings, solid drawn conduit is used.

Quayside and Reception Siding Lighting

The illumination of quaysides by broad beam floodlighting fittings supported on the transit shed eaves, mounted about 25-ft. above the ground, spaced approximately 100-ft. apart and giving an average illumination of 0·5-ft. candle, is satisfactory; the brightness can be increased to 2-ft. candles or more by switching on crane pedestal floodlights during cargo operations. Tungsten-filament lighting is normal for such installations, since the damage rate is high, requiring minimum capital costs. Floodlighting towers carrying six floodlights or more, comprising narrow, medium and broad fittings suitably focussed, each of 1-1·5 kW rating at 60-70-ft. mounting heights and approximately 300-ft. centres, are a noticeable trend for open berths, such towers being fed by underground cables and giving an even illumination of about 0·5-ft. over wide areas.

Different principles are applied to the lighting of reception sidings. It is unnecessary and uneconomic to illuminate such areas completely, since the shutters carry hand-lamps for signalling purposes after dark and their walking way is adequately lit. The aim should be to provide suitable lighting where tracks converge to railway points and crossings. Distributive fittings mounted on wood poles about 20-ft. above the ground and fed by overhead tier construction are adequate.

Where reception sidings converge to operating sidings of such equipment as coal hoists, general illumination of 1-2-ft. candles is provided in the working area. Broad beam floodlighting fittings, supplemented where necessary by suitably sited distributive fittings, give satisfaction.

Electrical Supplies for Shipping

In order to obtain a quick turn-round, many ships resort to double-shift working, often necessitating rigging of temporary lighting in the holds by means of t.r.s. cable and multiway couplers. For safety in these onerous working conditions, the voltage of supply should be 110 volts (55 volts to earth).

Both a.c. and d.c. supplies are required for shipping undergoing repair in the wet box; a.c. supplies are taken direct from the crane plug-boxes or adjacent substations, and d.c. supplies are provided by portable motor generator or rectifier sets.

MAINTENANCE ORGANISATION

While it is appreciated that wide variations of conditions and organisation exist, when docks are grouped into large units the maintenance staff should be just sufficient at each dock to carry out efficiently the day-to-day maintenance, emergency repairs and small new works installations, with local responsibility for maintaining the unit to a set standard. To deal with peak demands of heavy maintenance and new works, h.v. cable and substation installations, etc., a mobile team, centrally based and directed, should be sent on a programmed basis to each dock as required. To comply with Docks Regulations and check that the set maintenance standard is achieved, a centrally controlled inspection team should examine the equipment annually, reporting their findings to the group electrical engineer and to the engineer of the dock concerned. This team should inspect all installations carried out by direct labour or by contractors on tenants' premises, to ensure compliance with The Institution's Regulations, and also should assist the professional enginering staff in the acceptance testing of large new works. A centrally sited winding repair and meter test centre can be justified for such a group of ports.

While organisations vary widely, maintenance control is usually by allocation of specified staff to a dock area, giving them responsibility for maintaining the appliances and attending to any breakdowns occurring in that area. This method gives a sense of responsibility and effectively maintains the plant if the staff is of good quality, but is wasteful in manpower.

Recent work study investigations confirm that maintenance men employed in this manner on day work rates effectively work 40-50% of their booked time, but during breakdowns work harder and longer than operatives working at incentive speeds. Skilled staff shortages and present wage rates cannot permit these wasted man hours.

The alternative is fully planned preventive maintenance, with staff working at incentive speeds after the operations have been work-studied and rated, giving a higher wage rate to the staff and a lower maintenance expenditure with a considerable reduction in breakdown delays.

Fig 15 shows the organisation developed to suit dockside conditions applied successfully at Newport Docks and in course of being extended throughout the South Wales Group; and Table 6 indicates also typical "performance," "delay" and "not on bonus" time, showing effectively that, in addition to the greater effort of incentive conditions, considerable savings are possible by planning to eliminate waste time and improve methods. It is based on an inspection team, work loaded to a specified schedule, examining the appliances on a tonnage-handled/time basis, their findings being reported to the supervisor, who allocates priorities before handing to the planning department, which work loads the operative staff. It operates on a craftsman-and-mate basis, with increase in numbers to suit the specified job, each team being loaded daily with more than a full day's work. Delays must be reported immediately to the planning department for "stop time" to be allowed. Minor breakdowns are met by allocating some staff to low-priority work with the overriding instruction to attend any emergency, reporting facts and duration to the planning office, a check on this being given by operating department records. Major breakdowns are reported to the planning officers, who redeploy the required staff.

Fig. 16 indicates the installation of a crane plug box system carefully planned on the past experience of craftsmen, supervisors and engineers. While this was being installed the work was timed, rated and method studied, and the improved method, which has been employed many times since, was developed.

In addition to monetary savings, the effectiveness of a Planned Maintenance Scheme can be assessed by the reduction in plant outages which are obtained, and Fig. 17 indicates a comparison between 1959 and 1960 for a craneage quay.

At the commencement of 1959, when Planned Maintenance was applied, there were forty-five cranes, and this number was gradually increased by the construction of new cranes, which, with their consequential teething troubles, tended to increase the number of delays, until by the latter half of 1960, when these difficulties had been overcome, and the full complement of sixty-five cranes was effective, the delays were considerably reduced. This delay figure per 1,000 tons has been effectively maintained during 1961.

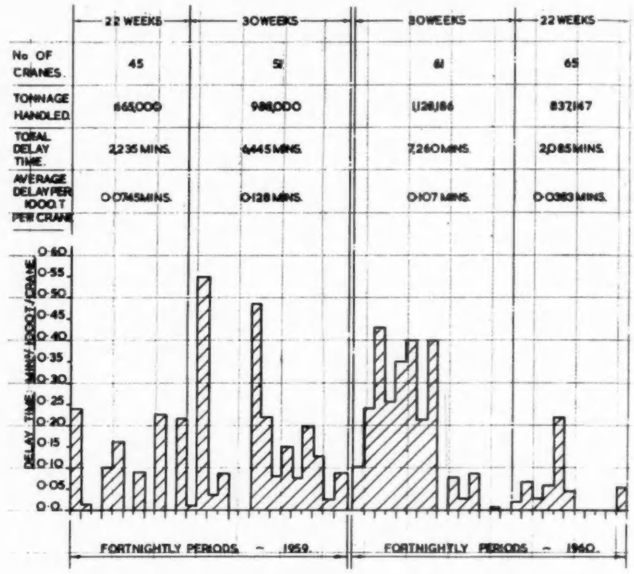


Fig. 17. Operational delays to electric cranes.

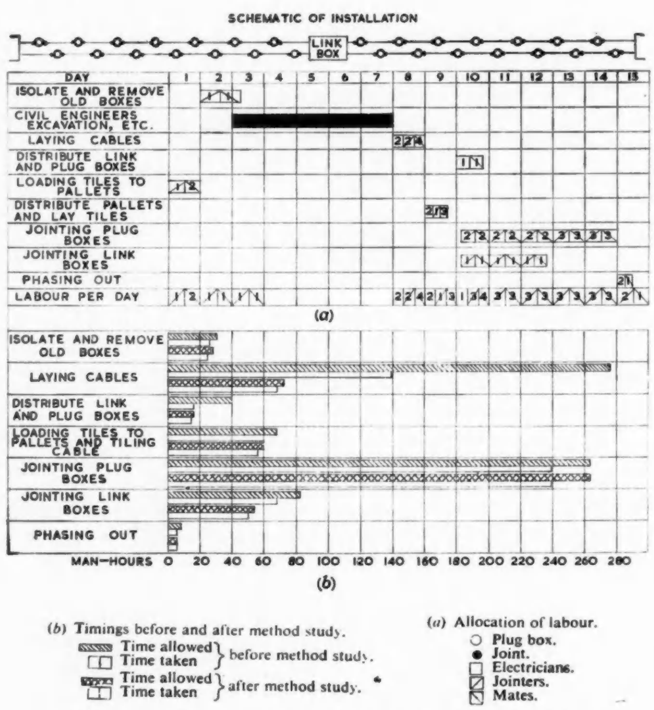


Fig. 16. Method study for crane-service plug-box installation.

Acknowledgments

The author wishes to thank the General Manager and Members of the Docks Board of Management of the British Transport Commission for permission to prepare the paper, and also his friends and colleagues of the dock industry who have assisted by helpful criticism and a readiness to prepare diagrams and collect data for its presentation.

Trade at Canadian Ports during 1960

Harbour traffic in 1960 at the Canadian ports of Halifax, Saint John, Chicoutimi, Quebec, Three Rivers, Montreal, Churchill and Vancouver, and the Government grain elevators at Prescott and Port Colborne, surpassed all previous records. In the annual report of the National Harbours Board, it is stated that vessel arrivals numbered 47,462, the aggregate net registered tonnage being 60,178,622. The comparable figures for 1959 were 48,173 vessels aggregating 57,417,941 net registered tons. Aggregate cargo tonnage was 52,222,526 as compared with 48,668,444 in 1959, an increase of 3,554,082 tons or 7 per cent. Grain traffic, showed a 10 per cent decrease compared with 1959.

Foreign inward traffic increased by 1,942,962 tons or 15 per cent, while foreign outward traffic rose by 498,451 tons or 3 per cent over the 1959 figures. Domestic inward traffic increased by 193,330 tons or 1·5 per cent and outward the figure rose by 919,348 tons or 12 per cent compared with 1959.

Major construction projects completed or in progress during the year included new or improved wharves at Halifax, Quebec, Montreal and Vancouver; new transit sheds at Quebec, Three Rivers, Montreal and Vancouver and extension to a transit shed at Montreal; additions and/or improvements to grain elevators, loading and unloading facilities and equipment at Halifax, Saint John, Quebec, Montreal, Prescott and Vancouver; expansion and/or improvements to the electrical system at Halifax, Quebec and Montreal; installation of refrigeration equipment at Vancouver.

New Floating Dock at Hamburg

With Special Reference to the Mechanical and Electrical Equipment

In 1959 a new floating dock was put into commission at the Howaldtswerke shipyard in the Port of Hamburg. The dock was constructed by Gutehoffnungshütte Sterkrade A.G. to designs prepared by Dockbaugesellschaft Hamburg. It has an overall length of 164.5m., an overall width of 35.2 m., and a clear internal width of 28.0 m. The length of the pontoon is 153.6 m., and the depth of water over the keel blocks when the dock is fully submerged is 8.0 m. The construction depth of the pontoon is 4.0 m. on the centre-line of the dock.

The dock is of the "box," or "trough," type, i.e., it is a continuous structure which does not allow of self-docking. On the assumption that the centre of gravity of the docked vessel is located 9.2 m. above its keel, adequate stability of the dock is ensured under all conditions of buoyancy and loading. To assist the discharge of water from the pontoon deck when the dock is being dewatered, four large rectangular openings have been provided in each side wall. The dock is of all-welded construction. Thanks to the use of carefully selected welding methods, including a substantial proportion of automatic welding, and the use of skilled welders, the finished structure possesses a high degree of dimensional accuracy, practically free from distortions.

The pumps, capstans, cranes and other mechanical equipment of the dock are electrically driven, the power being obtained from the 6 kV supply system of the shipyard and transformed down to the appropriate operating voltages. There are four main dewatering pumps. Dewatering the dock takes 115 minutes, from the moment the vessel settles down on the keel blocks until the pontoon deck emerges above water. The water ballast space of the dock is subdivided into eighteen compartments, which can be flooded and dewatered either individually or collectively.

The load assumptions on which the design of the dock was based make it suitable to accommodate any vessel of the appropriate dimensions to fit the dock. The pontoon is subdivided by two longitudinal partitions and five transverse bulkheads. In addition, there is a longitudinal truss on the centre-line of the pontoon, under the keel blocks, and numerous transverse trusses which in conjunction with the transverse frames, provide the necessary structural stiffening. This system is continued in the side walls up to the level of the safety decks. Above the safety decks a system of longitudinal trusses is provided.

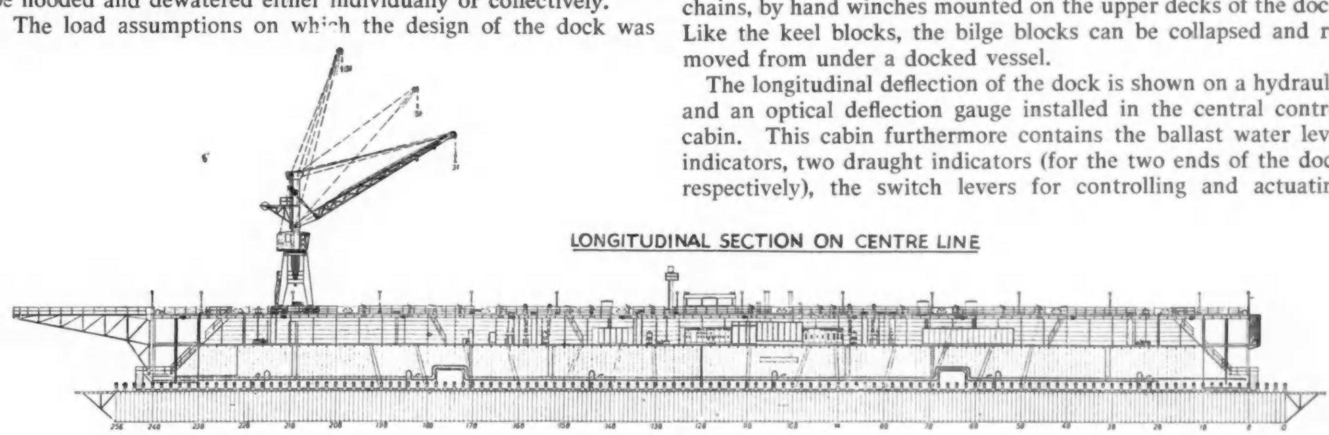
The safety decks are so called because, in the event of a mishap preventing closure of the flooding valves, they ensure sufficient buoyancy to prevent the dock from sinking completely. They are located 4 m. below the upper decks. As an additional precaution the space over each safety deck is subdivided by bulk heads into six compartments, in which the various items of mechanical and electrical equipment of the dock are accommodated.

There are 129 keel blocks, 1.2 m. in height and measuring 1.1 m. by 0.4 m. on plan. They are of welded construction. Each keel block has a top bearing plate sloped at about 1 in 10 in the transverse direction. Resting on this top plate is a steel wedge, likewise of welded construction, which serves to adjust the level of the block. The upper surface of the wedge is horizontal and carries a steel-sheathed hardwood cap which in turn is surmounted by a 75 mm. thick softwood strip on which the keel of the vessel rests. The various component parts of the keel blocks are securely connected to one another and to the pontoon, but can be disassembled to give access to any particular part of the vessel's keel wherever this may be necessary. The keel blocks do not bear directly on the pontoon deck, but are placed on thin softwood packings which serve to level out any "high spots."

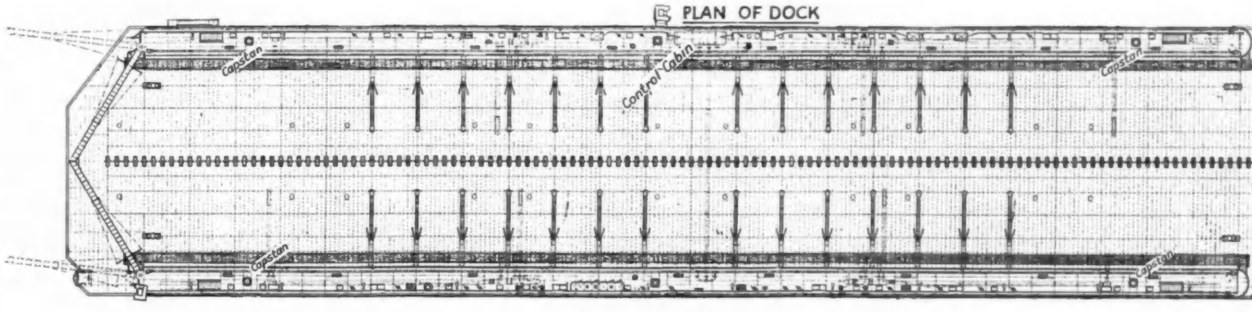
Lateral support to the vessel in dock is provided by fourteen pairs of bilge blocks. Each of these consists of a strong steel plate girder, of welded construction, provided with a timber capping strip. At its inner end the girder has a tilting bearing; the outer end is provided with a screw jack for adjustment. The screw jacks of the bilge blocks are operated, through endless chains, by hand winches mounted on the upper decks of the dock. Like the keel blocks, the bilge blocks can be collapsed and removed from under a docked vessel.

The longitudinal deflection of the dock is shown on a hydraulic and an optical deflection gauge installed in the central control cabin. This cabin furthermore contains the ballast water level indicators, two draught indicators (for the two ends of the dock respectively), the switch levers for controlling and actuating

LONGITUDINAL SECTION ON CENTRE LINE



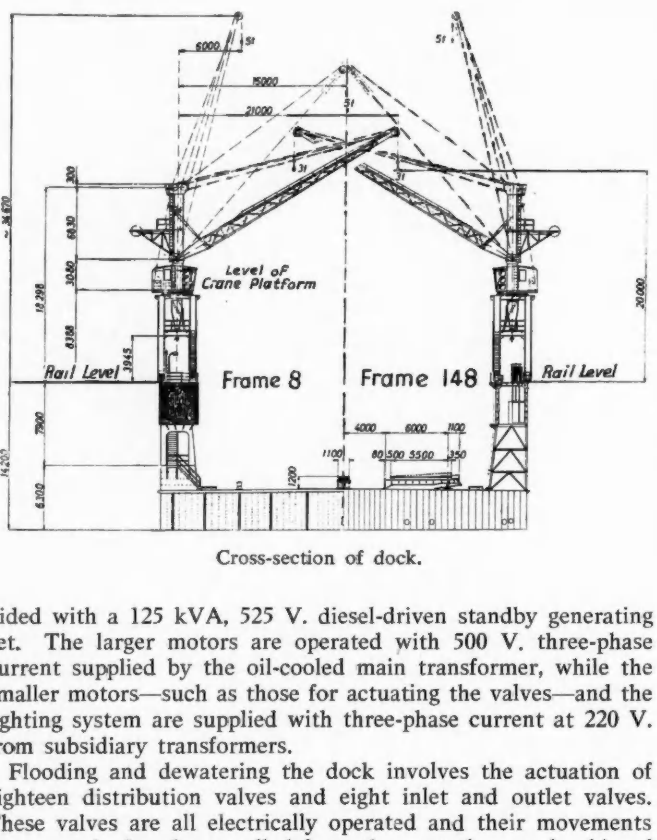
PLAN OF DOCK



motors of the inlet, outlet and distribution valves, the switches for the dewatering pumps, the lighting switches, an illuminated mock-up panel showing the dewatering and flooding system with the valve positions, an inclinometer for checking the longitudinal and transverse inclination of the dock, telephone and loudspeaker equipment, etc.

The services with which the dock is equipped comprise water mains for fire-fighting and cleansing purposes, freshwater supply mains, and a system of pipes delivering compressed air, steam, fire-extinguishing foam, acetylene and oxygen, together with the requisite valves and connection points. The crane equipment consists of two electric portal-mounted level-luffing jib cranes with lifting capacities of 3 tons (at 21 m. radius) and 5 tons (at 16 m. radius).

The electrical plant represents an installed capacity of 800 kVA, the power being supplied through an armoured flexible cable from the 6 kV mains of the shipyard. The dock is furthermore pro-



Cross-section of dock.

vided with a 125 kVA, 525 V. diesel-driven standby generating set. The larger motors are operated with 500 V. three-phase current supplied by the oil-cooled main transformer, while the smaller motors—such as those for actuating the valves—and the lighting system are supplied with three-phase current at 220 V. from subsidiary transformers.

Flooding and dewatering the dock involves the actuation of eighteen distribution valves and eight inlet and outlet valves. These valves are all electrically operated and their movements are supervised and controlled from the central control cabin of the dock. The switches on the control panel are provided with indicator lamps. When a valve actuating motor is switched on, the corresponding indicator lamp lights up. In the event of the motor failing to function, the lamp will start winking. In such an emergency the valve can be operated by hand. The end position of each valve is indicated by an illuminated area on the mock-up panel in the control cabin. A red area signifies that the valve is open; a white area signifies that it is closed.

The dock is equipped with six capstans for manœuvring and accurately positioning a vessel entering or leaving the dock. A capstan of 8 tons capacity is installed at each of the four corners, and a 4-ton capstan at the centre of each side wall. There are four main dewatering pumps, two on each side of the dock. They are installed on the bottom of the pontoon. These pumps, which are of the vertical-spindle centrifugal type, are driven by squirrel-cage motors mounted on the safety deck and developing 100 h.p. at 720 r.p.m. Each pump can deliver 3060 m^3/hour against a 6.2 m. head. The fire-fighting pumps are driven by squirrel-cage motors of 75/22 h.p. output at 1470/975 r.p.m.

There is special electrical equipment for supplying alternating current or direct current of the appropriate voltage to the vessels acommodated in the dock. This equipment comprises oil-cooled transformers and selenium rectifiers. An important feature is the main welding plant, which incorporates a transformer and rectifier installation capable of supplying direct current at 2500 A. at 55-65 V. In addition, the dock is provided with a number of three-phase electricity supply points for transportable welding converter sets.

The upper decks are lighted by mercury-vapour lamps mounted on curved standards. The sides of the docked vessel are illuminated by ten floodlights on each side of the dock. The floodlights have 500 W. incandescent lamps in completely watertight cast aluminium fittings. The dockmaster in the central control cabin is in telephonic communication with the capstan operators and with other strategic points on either side of the dock. The entrance end of the dock is equipped with a set of powerful loudspeakers, with an effective range of about 400 m. for issuing instructions to vessels about to enter the dock. Further sets of loudspeakers are installed on the side walls.

Book Reviews

"Glossary of Cargo Handling Terms." By A. G. Course and R. B. Oram. Published by Brown, Son and Ferguson, Ltd., 52-58 Darnley Street, Glasgow, S.1. Price 12s. net.

This book, which contains the definitions of some 600 terms in use in the cargo handling industry is, the authors believe, the first attempt to produce such a comprehensive glossary. Not only does it include some of the older terms still in use and which have their origin in the commerce of sailing ships, but also as many as possible of the agreed definitions of the newer forms of mechanical equipment, such as pallets, containers and unit loads. As these latter are playing an increasing part in the turnround of shipping, it is important that confusion in their meanings should be avoided. The definitions of many of the terms used in the warehousing of staple imports to Great Britain are also included.

Cargo handling is, in itself, not a process that permits of a simple definition, but the authors hope that this glossary will let a little light on to a subject that has remained undocumented for too long. It should be particularly useful to the staffs of shipping companies, forwarding agencies and like concerns.

Peiner Kastenspundwand (Peine Box-Section Sheet Piling), 296 pp., numerous illustrations. Published by Ilseder Hütte, Peine, 1960.

The Peine handbook, now in its third edition, contains the latest technical information on the steel piles manufactured by the well-known German firm of Ilseder Hütte. It gives a comprehensive survey of the design and construction of piled foundations and sheet piling based on the use of the Peine sections, particularly the broad-flange I-sections that can be installed side by side to form "box" type hollow assemblies which, in addition to possessing considerable strength and torsional rigidity, offer the advantage that they can be filled with concrete.

The book contains the following chapters: I, Properties and applications. II, Dimensions, weights, section properties, etc. III, Accessories and fittings. IV, Composite sheet pile walls (Peine box sections in combination with ordinary sheet pile

sections). V, Test-loading device for Peine piles. VI, Some examples of jobs in which Peine steel piles and box-section sheet piles were employed. VII, Design of structures embodying Peine steel piles and box-section sheet piling. A comprehensive set of tables giving the dimensions, properties, etc. of the sheet-pile and other sections is contained in an appendix.

Chapter VI is of particular interest in that it presents an instructive overall picture of the versatility and possible uses of the Peine pile sections. The examples given relate to a large number of structures of various kinds: quay walls, bank protection walls, breakwaters, locks, bridge and other foundations, mooring dolphins, cofferdams, etc. Thanks to the many and excellent illustrations, this chapter will be especially appreciated by the designer in search of fresh ideas and suggestions.

The final chapter, dealing with the design of piled and sheet-piled structures (including mooring dolphins), is also of considerable interest. The theoretical matter is clearly and concisely presented. A particularly useful feature of this chapter consists in the detailed numerical examples illustrating the application of the theory to practical design problems: (1) an anchored sheet-pile quay wall ; (2) a quay wall consisting of a reinforced concrete superstructure supported on a piled foundation; (3) a sheet-pile quay wall anchored by raker piles; (4) a mooring dolphin for 10,000-ton vessels; (5) dolphins for 1,000-ton vessels.

"Ports of the World," 15th Edition, edited by Donald Maxwell. Published by The Shipping World Ltd., 127 Cheapside, London, E.C.2. Price £5 net, postage and packing 3s. extra.

The changes in port dues and charges and in pilotage and towage rates in ports throughout the world have been so extensive during the last twelve months that all previous editions of this book have been rendered out of date. Currency changes in South Africa and the U.S.S.R. are reflected in new scales of charges for both countries and charges at the French ports are expressed in terms of the New Franc. A table of international currencies with their approximate values in relation to the pound Sterling and the U.S. Dollar is given in the front of the volume.

As usual, a considerable amount of new material has been added, including about 40 new port entries and several new introductory sections dealing with national conditions and charges and illustrated with plans. The practice of presenting more information in tabular form has been extended.

In fulfilling its main function of providing details of accommodation, services and expenses at nearly 2,000 ports of the world, this standard reference work goes into considerable detail, listing *inter alia* quay lengths and depths, cargo handling equipment, bunkering and repair facilities, principal imports and exports, pilotage arrangements and fees and the names of the main officials.

"Fire Aboard." By Frank Rushbrook, M.I.Fire.E. Published by The Technical Press, Ltd., 112 Westbourne Grove, London, W.2. Price 63s. net.

In this well-written and very interesting book, Mr. Rushbrook has made an exhaustive survey of all aspects of fire danger, prevention and control in ships and port installations. He first analyses six major disasters to ships at sea and in port, and seven major port disasters, describing the course of each fire and the results of each of the inquiries that followed. There follows a section on the British regulations for the prevention and control of fire at sea, which were drawn up as a result of the International Convention for the safety of Life at Sea, 1948, and here Mr. Rushbrook compares them with their American counterparts drawn up at the same time, greatly to the advantage of the latter for clarity, layout, comprehensiveness and intelligibility. The application aboard British ships of the Merchant Shipping (Fire Appliances) Rules, 1952 is next considered, with numerous diagrams and illustrations of fire-fighting equipment and of the Merchant Shipping (Construction) Rules, 1952, insofar as they bear on fire prevention and control problems. The various incombustible materials are described, one or more of which are now standard fittings for the bulkheads of British ships.

Other chapters deal with the protection of port installations against fire, the training of ships' personnel, the principles of fire-fighting in ships both in port and at sea, and the urgent need for standardisation of basic fire-fighting equipment and deck nomenclature.

The author, who is now Assistant Firemaster of the South-East of Scotland Fire Brigade, was until recently Chief Fire Officer of the County Borough of East Ham Fire Brigade whose area includes the famous "Royal" Group of London Docks, and it was here that he gained much of his wide experience. He has a clear and critical approach to the subject and his book should be valuable to all connected with ships and harbours and to fire-fighters and Insurance Companies.

Trackwork Engineering. Produced by Edgar Allen and Co. Ltd., Imperial Steel Works, Sheffield 9.

In recent years we have seen the emergence of a realistic attitude to railway development works wherein increasing attention is given to the minimising of track maintenance work and to the increasing of track life. Major changes in track design have followed the introduction of the now almost universal flat bottom rail, and expansion work in U.K. and in Commonwealth and foreign railways, has led to increasing activity in the modernisation of dockyards and industrial railways and in the provision of layouts for new industrial plants.

Edgar Allen and Co. Ltd., who specialise in the production of rolled austenitic manganese steel trackwork and in castings of this material for crossings, switches and other railway equipment, has produced a handbook of trackwork engineering which contains a wealth of useful information. The volume, which includes a large number of photographs, is produced to a high standard and is in loose leaf form within hardback covers.

The scope of the handbook is somewhat difficult to define as an attempt has been made to combine the functions of a catalogue advertising the firm's products and those of a design manual, together with a guide to tracklaying procedure. As a catalogue of products the production is excellent although some essential details (for example, of "Contractors" switches and crossings) are surprisingly excluded. Considered as a design manual, the information given, in spite of the inclusion of an index, is curiously difficult to locate until one has become thoroughly familiar with the contents. For example, no particulars are included of BR 109-lb. F.B. rail in the appropriate table on page 11. Again a glossary of terms relating to crossings is given but no such glossary for switches and timbers is included. In a work of this very high standard we should have expected the inclusion of a note upon the selection of the correct type of BR switch for the particular 109 F.B. rail turnouts listed on pp. 115-120. The tables and calculations included in the General Information chapter are well presented, but it might assist quick reference to include cross references to the various tables within the text of the general index.

The manual includes a useful section, confined to trackwork and fittings 126-2-lb. dock rail, upon Industrial and Dock Railways.

Golden Jubilee of the Ocean Dock, Southampton

Last month marked the golden jubilee of the Ocean Dock at Southampton for, although there was no ceremonial opening, it was used for the first time on 14th June, 1911, when the White Star liner *Olympic* sailed from Nos. 43-44 berths for New York on her maiden voyage, thus beginning a long association with the North Atlantic passenger trade.

The dock was originally called the White Star Dock, the primary reason for its construction being the transfer by the White Star Line of their North Atlantic express service from Liverpool to Southampton, commencing with the *Adriatic* in 1907. The name was changed to Ocean Dock in 1922 following the use of the dock by other famous companies, notably Cunard Line, which transferred its express service to Southampton after the first world war.

Construction of the dock was commenced in 1906 under the direction of the late Mr. F. E. Wentworth-Sheilds, then docks engineer. At that time the docks extended as far as No. 40 berth, where the cold store had been completed in 1904, and although to the west the Trafalgar drydock had been opened in 1905, the intervening area, which was to become the site of the new basin, consisted of mudland, the crossing from No. 40 berth to the drydock area being effected by a chalk bank. This bank crossed the extreme south end of the site and in the building of the dock it was used as a temporary dam to exclude the tide, thus enabling Nos. 43, 44, 45, 46 and part of 47 berths to be constructed "in the dry." The walls to the south of the bank (viz. Nos. 48, 49, the jetty at 42 and part of 47 berths) had to be built by submarine construction. The remaining wall, No. 41 berth, was built in a dry trench, sunk into the heart of the bank itself.

Fig. 1 shows the progress which had been made with the dock by the early part of 1911, and by June of that year work on Nos. 43-44 berths was sufficiently far advanced to allow the 46,439-ton liner *Olympic* to berth there prior to her maiden sailing on 14th June. Alongside this side of the dock can be seen the completed passenger

Fig. 1. Ocean Dock nearing completion in June, 1911.

and cargo shed, with the quayside cranes, which, incidentally, were the first electric quayside cranes to be introduced at Southampton Docks. At the north end of the shed can be seen two passenger gantries from which the gangways were placed to connect the doorways of the liner to the high-level balcony of the shed—anticipating by some forty years the power-operated telescopic gangways used in the Ocean Terminal to-day! Other features of interest in the picture are the cold stores premises, seen in the left background, the then newly-completed White Star and American Line's dock store building on the right, and, at the uncompleted quay on the right of the picture (now No. 46 berth) the Union-Castle liner *Carisbrooke Castle*, the second of the Union-Castle mail ships to bear this name, built in 1898 and broken up in 1922.

In addition to the *Olympic*, some of the first ships to use the dock regularly were the White Star liners *Majestic* (the first liner of that name), *Oceanic* and *Teutonic*. Then there was the *Titanic*, which sailed from No. 44 berth on 10th April, 1912, on her ill-fated maiden voyage.

After the first world war Cunard followed White Star in transferring their North Atlantic express service from Liverpool to Southampton, and the first Cunard ship to sail from the White Star

Fig. 2. Ocean Dock as it is to-day.

Dock was the *Aquitania*, which embarked 5,000 Canadian troops and sailed for Canada on 14th June, 1919. She was followed by the *Mauretania* and *Berengaria*, and, as previously stated, the use of the dock by Cunard and other companies led, in 1922, to the name being changed from White Star Dock to Ocean Dock.

In the 'thirties the dock was the home of many famous liners, including what were known as "the big seven"—*Majestic, Olympic* and *Homeric* of the White Star Line, *Berengaria, Mauretania*, and *Aquitania* of Cunard and the *Leviathan* of United States Lines. The largest of these liners was the *Majestic* of 56,550 gross tons, but in 1936 the *Queen Mary*, of 81,237, became the largest liner to be based on Ocean Dock, followed after the war by the *Queen Elizabeth* of 83,673 tons.

When completed, the Ocean Dock had a water area of 15½ acres, a depth of water at low water of 40-ft. and a total of 3,707-ft. of berthing space. The dock was 400-ft. in width. It was equipped with four passenger and cargo sheds, two at Nos. 43-44 berths on the eastern side and two on the western side, Nos. 46-47 berths. The two at Nos. 43-44 berths were damaged during the second world war and were replaced in 1950 by the Ocean Terminal, which set an entirely new standard in passenger reception.

During its fifty years Ocean Dock has been the home of a succession of famous liners and has served Britain well both in time of peace and war.

The Association of Underwater Contractors

The above Association has been formed of firms carrying on business as Underwater Contractors and Divers. Its general objects are to further goodwill in relations between Members and clients.

The founder members are: Conroy Lewis Ltd., Southampton; Dockland Diving Engineers, Dagenham; Overseas Divers Ltd., Southampton; A. J. Parsloe, Brighton; Underwater Welders and Repairers Ltd., Cardiff; and Universal Divers Ltd., Liverpool.

Mr. W. S. Chalk and Mr. J. E. Fraser, V.C. have been elected Chairman and Vice-Chairman respectively and Mr. W. Strachan has been appointed Secretary. The address is Queen's House, Leicester Square, London, W.C.2.

Manufacturers' Announcements

Flameproof Sodium Lighting Fitting

A new 140 watt sodium lighting fitting for use in flameproof areas, including roadways and oil tanker landing jetties, has been developed by Heyes and Co. Ltd., of Wigan. This fitting is flameproof and weatherproof and is suitable for a wide range of applications. It will be of particular interest to the oil and petroleum industries and is expected to gain acceptance overseas.

Designed to take a type SO 140 watt sodium lamp, the unit gives an average output of 9,800 lumens for a lamp life of 4,000 hours. It is supplied in cast aluminium but is available in cast iron if required. The fitting has one cable entry for either gland or conduit up to 1-in. E.T. It has a length of 26⅞-in. (68·26 cms.); height of 8 7/16-in. (21·43 cms.); width of 6-in. (15·24 cms.); fixing centres of 22⅝-in. x 6-in. (57·46 x 15·24 cms.), 4 holes ⅜-in. (9·52 cms.) diameter; weight 24 lbs. (10·88 kgs.).

A new ballast unit designed to house the control gear of the sodium fitting has also been developed.

Diamond Drilling Division of Coventry Compressors Ltd.

A new division of Coventry Compressors Ltd., 32 Stewarts Road, London, S.W.8, has been formed to deal exclusively with the problems of penetrating all types of materials used in construction and installation work. Amongst the harder materials will be reinforced concrete, artificial stone, glazed wall tiles, quartz, refractory bricks, granite and marble.

By using hollow tubular steel drills tipped with industrial diamonds these materials can be drilled quickly and quietly. The machinery required is light and portable and is specially suited to work where excessive noise, dust and vibration are to be avoided. Although the equipment is portable, experience has shown that holes up to 12-in. diameter through 10-ft., or more of reinforced concrete can be rapidly drilled.

In the demolition of mass foundation, concrete or heavy brickwork, the portable diamond drill used in conjunction with an hydraulic burster provides the ideal combination for use in close proximity to occupied buildings. Diamond drilling, being rotary, eliminates the fear of structural damage and making good is unnecessary as the hole is clean and accurate.

The equipment is completely lacking in fire hazard making it invaluable in the petroleum, chemical, and mining industries, and when operated by a diver has proved its use in harbour and river works.

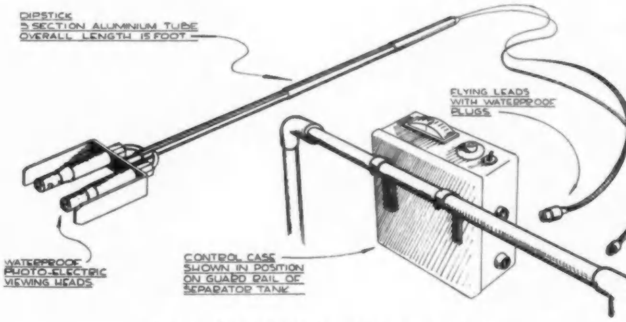
Sludge and Sediment Layer Interface Level Detector

Based on an original design by D.S.I.R. Water Pollution Research Laboratories, Stevenage, this equipment enables sludge level to be checked in Sewage Separating Tanks. The sludge level is of primary importance to avoid unnecessary tank shut downs, which would be necessary should it become excessive. Without this device it is possible for the danger level to be exceeded, leading to the closing down of the tank for several days and the resultant overloading of the remaining tanks and filter beds may result in inefficient purification of the sewage.

The equipment consists basically of a battery driven Photocell and Light Source, the output of the cell being fed back to a micro ammeter. The Photocell and Light Source of waterproof construction, are fitted to the end of a collapsible 15-ft. aluminium tube. The connections from the sensing head are brought into the Control Unit via waterproof plugs, and the Control Unit, which houses batteries, indicator etc., can be situated up to 10-ft. from the top of the sensing tube. Once the sensing tube has been assembled, it may be left so and the Control Unit unplugged and stored.

To operate the equipment it is simply necessary to plug the Photocell and Light Source leads into the sockets provided on the instrument case, adjust for maximum deflection of the meter, and slowly lower the sensing tube into the separate tank. When the sludge level is reached the meter reading will quite suddenly move towards zero, and the level can then be read off the markings on the sensing tube.

The instrument may of course be used to detect the level of any interface in open tanks, rivers, canals, dock basins, water purification settling tanks etc. It may also be used in chemical plants for interface level detection in open tanks but here due regard must be paid to the materials of construction. Special resins using all stainless steel, epoxy glues to S.S. window seals, and a more resistant cable could be developed to special order for such applications.



A complete set of detection equipment.

The measurement of interface level is becoming of increasing importance in the operation of settling tanks, defloculation processes, water purification works and also in the operation of clocks etc., where it is useful to know the level of any silt laden strata in the water. Suspended on long cables it could also be extremely useful in detecting interfaces of chalky or silt laden waters in wells, boreholes, and sumps to aid pumping operations.

One complete set of equipment for Sludge Level Detection, comprising 15-ft. aluminium tube, collapsible into three 5-ft. lengths, waterproof Light Source and Photocell sensing head, unpluggable Control Unit in sheet metal case containing batteries, operating switches and micro ammeter would cost £35.

PVC Waterstop for Sea Walls

This waterstop is specially designed to obviate the use of a sealing compound and thus withstand the severe buffeting caused by wave action and high seas. It is based on the well tried Expandite Hydrofoil profile to which has been added a hollow portion, at right angles to and in front of the waterstop, to fill the cavity between adjacent pours of concrete. At the back, the profile is slotted to take ½-in. thick joint filler.

The waterstop is manufactured from high grade PVC (polyvinyl chloride), with suitable plasticisers and contains no fillers or scrap material. The following are the physical properties at 25°C: tensile strength 2,000 p.s.i. (min.); elongation at break 250% (min.); B.S. softness 42-52; water absorption 2·5-3·0%; cold crack temperature not higher than −25°C.

In a number of cases, PVC is more resistant to chemical attack than natural rubber, particularly with respect to oxidation.

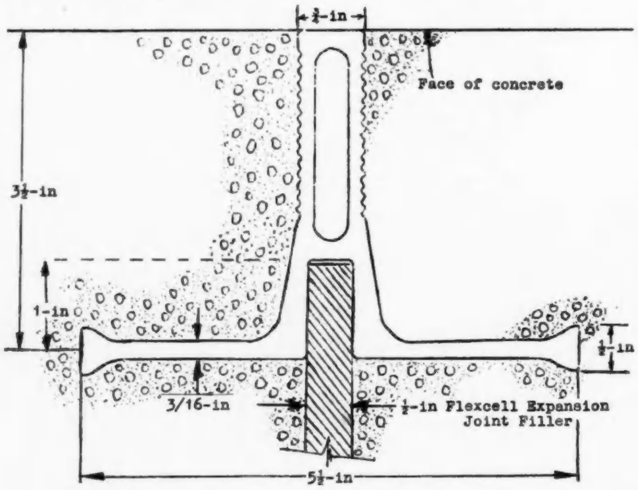
A sample taken and immersed in 5% sodium chloride for one year gave the following results when compared with a non-immersed control sample:

	Tensile Strength (p.s.i.)	Elongation at Break %
Control sample ...	2,393	263
Immersed sample ...	2,443	256

It will be seen from the above that no significant deterioration

in physical properties occurred. The waterstop will, therefore, be unaffected by sea water.

It is primarily intended for use in expansion joints in sea walls, but may also be used in other applications such as culverts where a PVC waterstop is suitable for the conditions and, secondly, where the absence of a sealing compound, which might ordinarily be displaced in service, will be an advantage.



The above indicates the position of the waterstop in relation to the concrete and joint filler.

Intersections and jointing will best be made in the factory, due to the nature of the profile. Since the waterstop can only be bent to follow a gradual curve, it will be necessary to have mitres wherever a sharp change in direction is involved.

Straight butt joints can be made on site in accordance with the printed instructions issued by Expandite Ltd. for the jointing of PVC waterstop.

It is supplied normally in 15-ft. straight lengths, but special fabrications can be supplied as required.

Contracts for Bolton Gates

Bolton Gate Co. Ltd., leading manufacturers of collapsible gates and doors, doubled their exports during the six months ended March 31st last, and are now selling to more than thirty countries. Current orders are in hand from Canada, New Zealand, South Africa, Ghana, West Indies, Singapore, Fiji, British West Africa and Eire.

The bulk of this business concerns collapsible gates, shutter doors, Superfold partitions, traffic booms and automatic glass doors. Twenty-four pairs of Bolton Patent shutter doors—each 26-ft. in width—will be supplied to Auckland Harbour Board for use on the Freyberg Wharf Scheme and shutter doors will also be shipped to Ghana for installation at a power station.

Radiotelephone Network for Iraqi Ports Authority

A contract to the value of approximately £100,000 has been signed by the Iraqi Ports Authority and Pye Telecommunications Ltd. of Cambridge for the supply and installation of a v.h.f. and u.h.f. radiotelephone network for the following services:

(a) V.H.F. telephone services at Margil for Basrah Airport; the Ports' Ambulance; Fire-fighting Units; Electricity Distribution Department and the Maritime Services; (b) four other v.h.f. communication systems for the Maritime Services at Al-Wasillah, Fao, the Deep Water Berth and Um Qasir; (c) A u.h.f. telephone link between Fao and the Deep Water Berth and a v.h.f. telephone service aboard the Ports' Maritime vessels is also included.

New Headquarters for the Steel Group

The Steel Group of Companies, which represents the largest group in the world manufacturing mobile cranes, has moved from its various offices in the West End of London to Steel House, Eastcote, Pinner, Middlesex. Comprising Steel and Co. Ltd., Steels Engineering Products Ltd., Steels Engineering Installations Ltd., Steels Process Plants Ltd., Archibald Low and Sons Ltd., R. H. Neal and Co. Ltd., Pelapone Ltd., F. Taylor and Sons (Manchester) Ltd. and the British Crane Co. Ltd. the Group's activities are separated into handling and process divisions. The sales operations for all the companies will now be organised from Steel House.